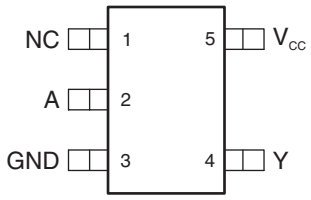
LOW POWER, 1.8/2.5/3.3-V INPUT, 3.3-V CMOS OUTPUT, SINGLE SCHMITT-TRIGGER INVERTER GATE

Check for Samples: SN74AUP1T14

FEATURES

- **Single-Supply Voltage Translator**
- **Output Level Up to Supply V_{CC} CMOS Level**
  - **1.8 V to 3.3 V (at V_{CC} = 3.3 V)**
  - **2.5 V to 3.3 V (at V_{CC} = 3.3 V)**
  - **1.8 V to 2.5 V (at V_{CC} = 2.5 V)**
  - **3.3 V to 2.5 V (at V_{CC} = 2.5 V**
- **Schmitt-Trigger Inputs Reject Input Noise and Provide Better Output Signal Integrity**
- **I_{off} Supports Partial Power Down (V_{CC} = 0 V)**
- **Very Low Static Power Consumption: 0.1 µA**
- **Very Low Dynamic Power Consumption: 0.9 µA**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **Pb-Free Packages Available: SC-70 (DCK) 2 x 2.1 x 0.65 mm (Height 1.1 mm)**
- **More Gate Options Available at www.ti.com/littlelogic**
- **ESD Performance Tested Per JESD 22**
  - **2000-V Human-Body Model (A114-B, Class II)**
  - **1000-V Charged-Device Model (C101)**

DCK PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The SN74AUP1T14 performs the Boolean function Y = $\overline{A}$ with designation for logic-level translation applications with output referenced to supply V_{CC}.

AUP technology is the industry's lowest-power logic technology designed for use in extending battery-life in operating. All input levels that accept 1.8-V LVCMOS signals, while operating from either a single 3.3-V or 2.5-V V_{CC} supply. This product also maintains excellent signal integrity (see Figure 1 and Figure 2).

The wide V_{CC} range of 2.3 V to 3.6 V allows the possibility of switching output level to connect to external controllers or processors.

Schmitt-trigger inputs (ΔV_T = 210 mV between positive and negative input transitions) offer improved noise immunity during switching transitions, which is especially useful on analog mixed-mode designs. Schmitt-trigger inputs reject input noise, ensure integrity of output signals, and allow for slow input signal transition.

I_{off} is a feature that allows for powered-down conditions (V_{CC} = 0 V) and is important in portable and mobile applications. When V_{CC} = 0 V, signals in the range from 0 V to 3.6 V can be applied to the inputs and outputs of the device. No damage occurs to the device under these conditions.

The SN74AUP1T14 is designed with optimized current-drive capability of 4 mA to reduce line reflections, overshoot, and undershoot caused by high-drive outputs.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING(3)
–40°C to 85°C	SOT (SC-70) – DCK	Reel of 3000	SN74AUP1T14DCKR	6F_
		Reel of 250	SN74AUP1T14DCKT	

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(3) The actual top-side marking has one additional character that designates the wafer fab/assembly site.

FUNCTION TABLE

INPUT (Lower Level Input)	OUTPUT (V_{CC} CMOS)
A	Y
H	L
L	H

Supply V_{CC} = 2.3 V to 2.7 V (2.5 V)

INPUTS V_{T+} max = V_{IH} min, V_{T-} min = V_{IL} max		OUTPUT CMOS
A	B	Y
V_{IH} = 1.1 V		V_{OH} = 1.85 V
V_{IL} = 0.35 V		V_{OL} = 0.45 V

Supply V_{CC} = 3 V to 3.6 V (3.3 V)

INPUTS V_{T+} max = V_{IH} min, V_{T-} min = V_{IL} max		OUTPUT CMOS
A	B	Y
V_{IH} = 1.19 V		V_{OH} = 2.55 V
V_{IL} = 0.5 V		V_{OL} = 0.45 V

LOGIC DIAGRAM (SCHMITT-TRIGGER INVERTER GATE)

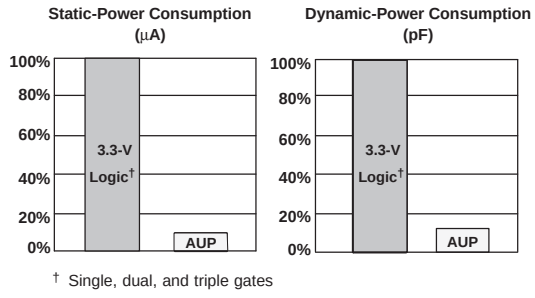


Figure 1. AUP – The Lowest-Power Family

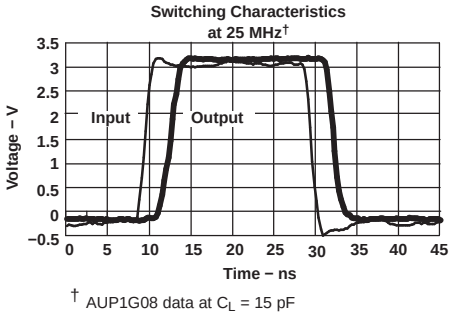


Figure 2. Excellent Signal Integrity

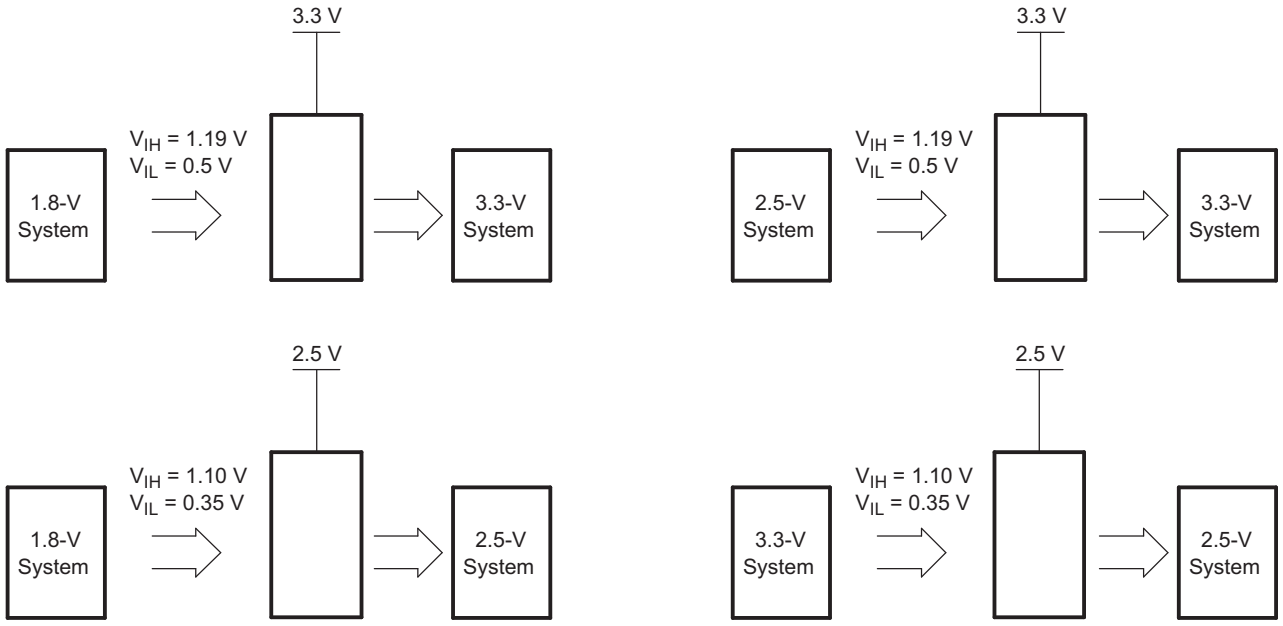


Figure 3. Typical Design Examples

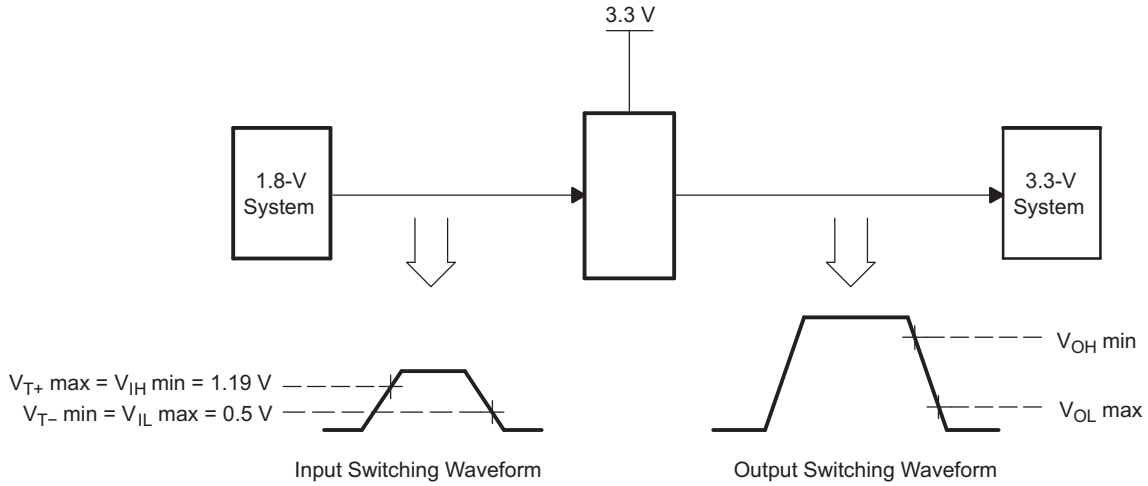


Figure 4. Switching Thresholds for 1.8-V to 3.3-V Translation

ABSOLUTE MAXIMUM RATINGS(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	4.6	V
V_I	Input voltage range(2)		–0.5	4.6	V
V_O	Voltage range applied to any output in the high-impedance or power-off state(2)		–0.5	4.6	V
V_O	Output voltage range in the high or low state(2)		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	V_I < 0		–50	mA
I_{OK}	Output clamp current	V_O < 0		–50	mA
I_O	Continuous output current			±20	mA
	Continuous current through V_{CC} or GND			±50	mA
θ_{JA}	Package thermal impedance(3)	DCK package		259	°C/W
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage		2.3	3.6	V
V_I	Input voltage		0	3.6	V
V_O	Output voltage		0	V_{CC}	V
I_{OH}	High-level output current	V_{CC} = 2.3 V		–3.1	mA
		V_{CC} = 3 V		–4	
I_{OL}	Low-level output current	V_{CC} = 2.3 V		3.1	mA
		V_{CC} = 3 V		4	
T_A	Operating free-air temperature		–40	85	°C

(1) All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. See the TI application report *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	V_{CC}	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
V_{T+} Positive-going input threshold voltage			2.3 V to 2.7 V	0.6		1.1	0.6	1.1	V
			3 V to 3.6 V	0.75		1.16	0.75	1.19	
$V_{T–}$ Negative-going input threshold voltage			2.3 V to 2.7 V	0.35		0.6	0.35	0.6	V
			3 V to 3.6 V	0.5		0.85	0.5	0.85	
ΔV_T Hysteresis ($V_{T+} – V_{T–}$)			2.3 V to 2.7 V	0.23		0.6	0.1	0.6	V
			3 V to 3.6 V	0.25		0.56	0.15	0.56	
V_{OH}		I_{OH} = –20 μA	2.3 V to 3.6 V	V_{CC} – 0.1			V_{CC} – 0.1		V
		I_{OH} = –2.3 mA	2.3 V	2.05			1.97		
		I_{OH} = –3.1 mA		1.9			1.85		
		I_{OH} = –2.7 mA	3 V	2.72			2.67		
		I_{OH} = –4 mA		2.6			2.55		
V_{OL}		I_{OL} = 20 μA	2.3 V to 3.6 V			0.1		0.1	V
		I_{OL} = 2.3 mA	2.3 V			0.31		0.33	
		I_{OL} = 3.1 mA				0.44		0.45	
		I_{OL} = 2.7 mA	3 V			0.31		0.33	
		I_{OL} = 4 mA				0.44		0.45	
I_I	All inputs	V_I = 3.6 V or GND	0 V to 3.6 V			0.1		0.5	μA
I_{off}		V_I or V_O = 0 V to 3.6 V	0 V			0.1		0.5	μA
ΔI_{off}		V_I or V_O = 3.6 V	0 V to 0.2 V			0.2		0.5	μA
I_{CC}		V_I = 3.6 V or GND, I_O = 0	2.3 V to 3.6 V			0.5		0.9	μA
ΔI_{CC}		One input at 0.3 V or 1.1 V, Other inputs at 0 or V_{CC}, I_O = 0	2.3 V to 2.7 V					4	μA
		One input at 0.45 V or 1.2 V, Other inputs at 0 or V_{CC}, I_O = 0	3 V to 3.6 V					12	
C_i		V_I = V_{CC} or GND	3.3 V		1.5				pF
C_o		V_O = V_{CC} or GND	3.3 V		3				pF

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V, V_I = 1.8 V ± 0.15 V (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	5 pF	1.8	2.3	2.9	0.5	6.8	ns
			10 pF	2.3	2.8	3.4	1	7.9	
			15 pF	2.6	3.1	3.8	1	8.7	
			30 pF	3.8	4.4	5.1	1.5	10.8	

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V, V_I = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	5 pF	1.8	2.3	3.1	0.5	6	ns
			10 pF	2.2	2.8	3.5	1	7.1	
			15 pF	2.6	3.2	5.2	1	7.9	
			30 pF	3.7	4.4	5.2	1.5	10	

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V, V_I = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	5 pF	2	2.7	3.5	0.5	5.5	ns
			10 pF	2.4	3.1	3.9	1	6.5	
			15 pF	2.8	3.5	4.3	1	7.4	
			30 pF	4	4.7	5.5	1.5	9.5	

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V, V_I = 1.8 V ± 0.15 V (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	5 pF	1.6	2	2.5	0.5	8	ns
			10 pF	2	2.4	2.9	1	8.5	
			15 pF	2.3	2.8	3.3	1	9.1	
			30 pF	3.4	3.9	4.4	1.5	9.8	

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V, V_I = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	5 pF	1.6	1.9	2.4	0.5	5.3	ns
			10 pF	2	2.3	2.7	1	6.1	
			15 pF	2.3	2.7	3.1	1	6.8	
			30 pF	3.4	3.8	4.2	1.5	8.5	

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V, V_I = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 5)

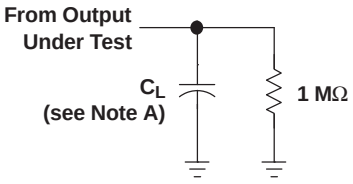
PARAMETER	FROM (INPUT)	TO (OUTPUT)	C_L	T_A = 25°C			T_A = –40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
t_{pd}	A	Y	5 pF	1.6	2.1	2.7	0.5	4.7	ns
			10 pF	2	2.4	3	1	5.7	
			15 pF	2.3	2.7	3.3	1	6.2	
			30 pF	3.4	3.8	4.4	1.5	7.8	

OPERATING CHARACTERISTICS

T_A = 25°C

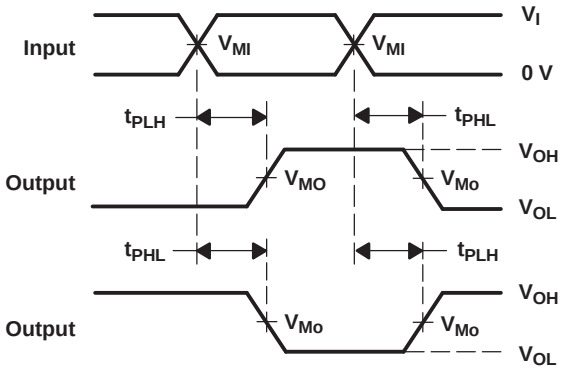
PARAMETER		TEST CONDITIONS	V_{CC} = 2.5 V	V_{CC} = 3.3 V	UNIT
			TYP	TYP	
C_{pd}	Power dissipation capacitance	f = 10 MHz	4	5	pF

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

	V_{CC} = 2.5 V ± 0.2 V	V_{CC} = 3.3 V ± 0.3 V
C_L	5, 10, 15, 30 pF	5, 10, 15, 30 pF
V_{MI}	$V_I/2$	$V_I/2$
V_{MO}	$V_{CC}/2$	$V_{CC}/2$



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS

NOTES: A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, slew rate ≥ 1 V/ns.
C. The outputs are measured one at a time, with one transition per measurement.
D. t_{PLH} and t_{PHL} are the same as t_{pd}.

Figure 5. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN74AUP1T14DCKR	Active	Production	SC70 (DCK) | 5	3000 | LARGE T&R	Yes	NIPDAU | SN	Level-1-260C-UNLIM	-40 to 85	6FF
SN74AUP1T14DCKR.B	Active	Production	SC70 (DCK) | 5	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	6FF
SN74AUP1T14DCKRG4	Active	Production	SC70 (DCK) | 5	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	6FF
SN74AUP1T14DCKRG4.B	Active	Production	SC70 (DCK) | 5	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	6FF

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

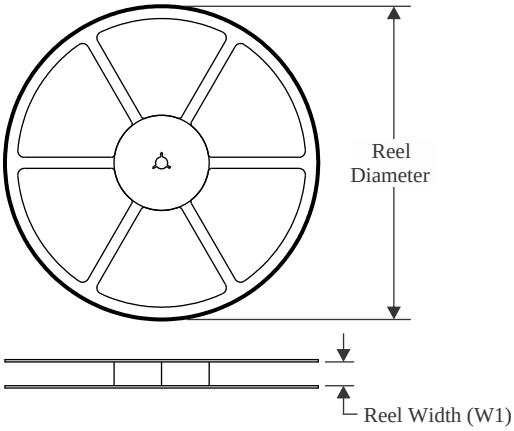
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

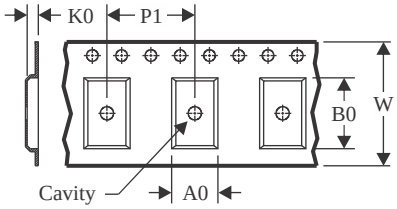
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

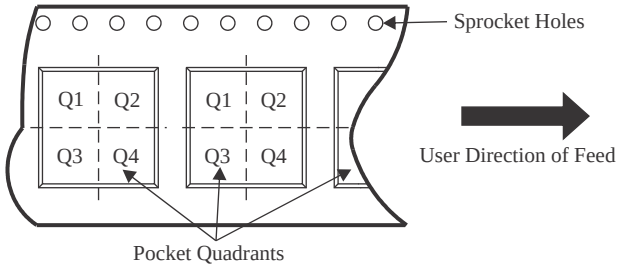


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

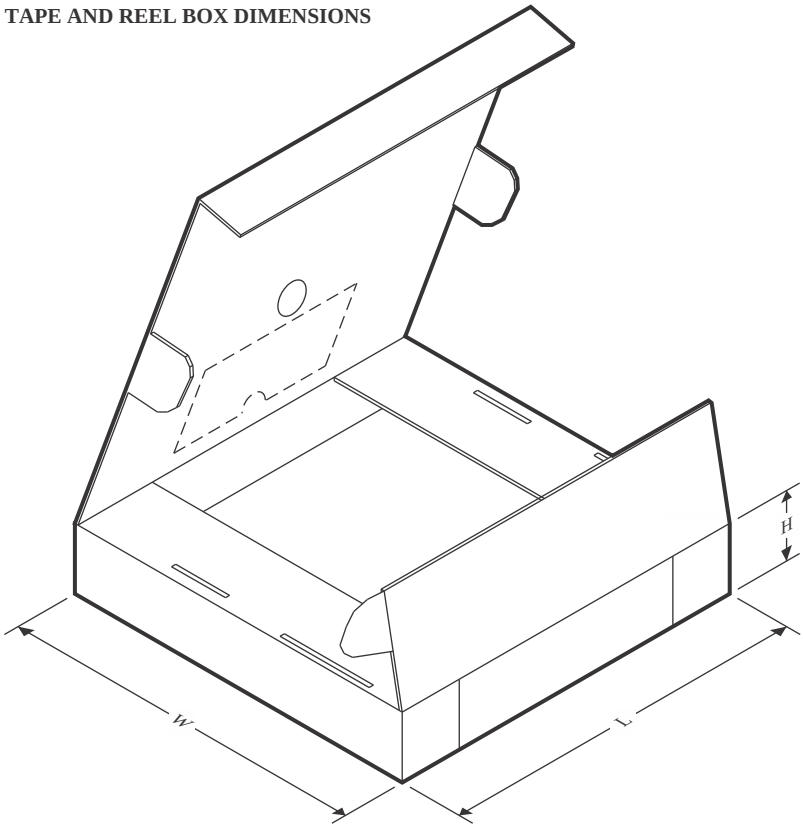
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74AUP1T14DCKR	SC70	DCK	5	3000	180.0	8.4	2.3	2.5	1.2	4.0	8.0	Q3
SN74AUP1T14DCKRG4	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

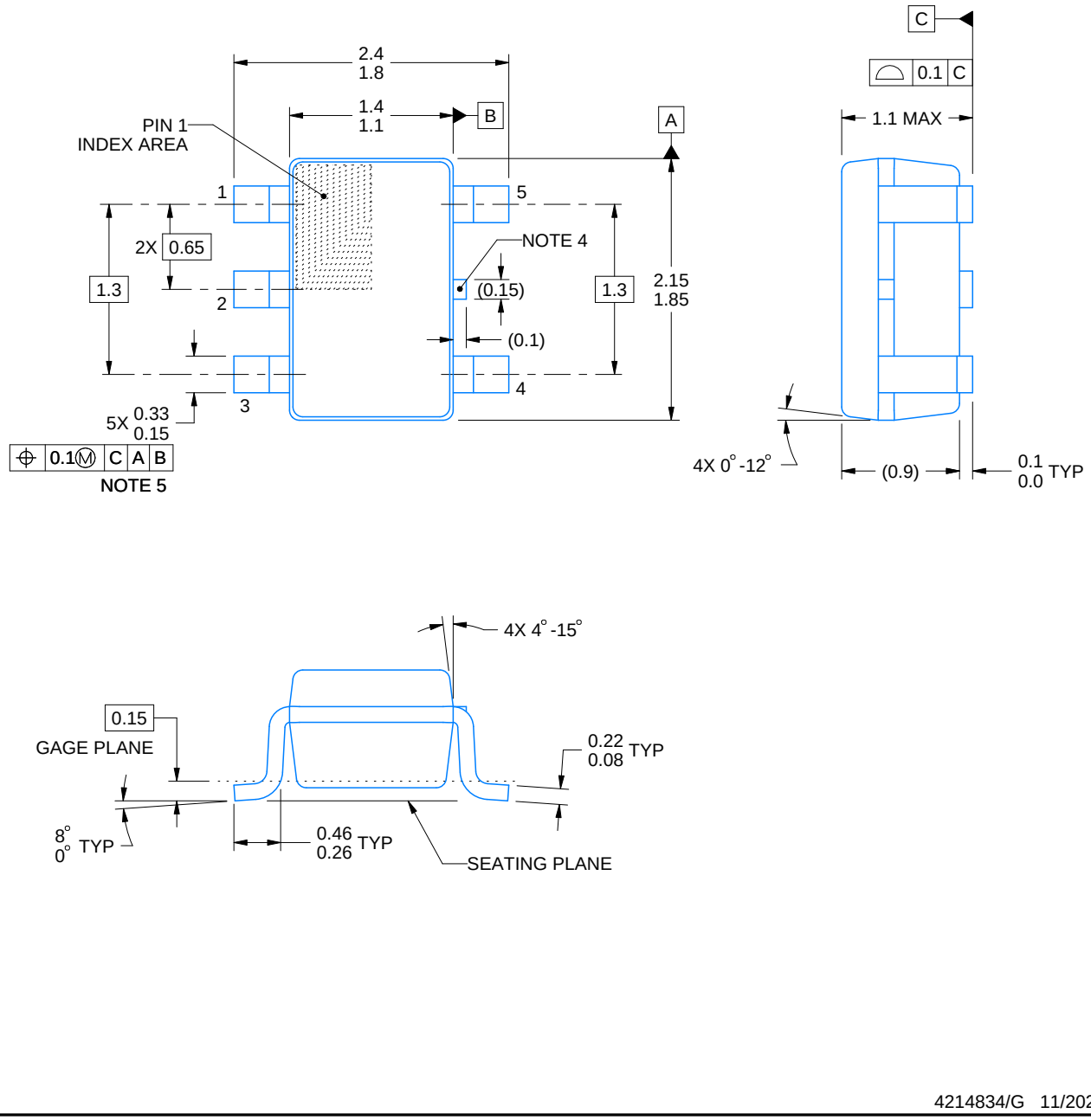
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AUP1T14DCKR	SC70	DCK	5	3000	210.0	185.0	35.0
SN74AUP1T14DCKRG4	SC70	DCK	5	3000	180.0	180.0	18.0

PACKAGE OUTLINE

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



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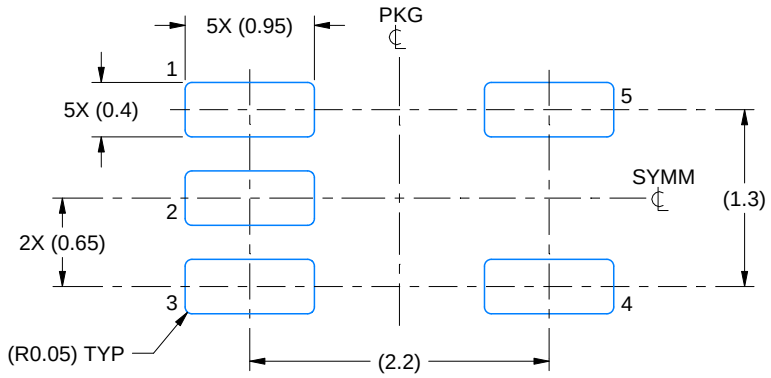
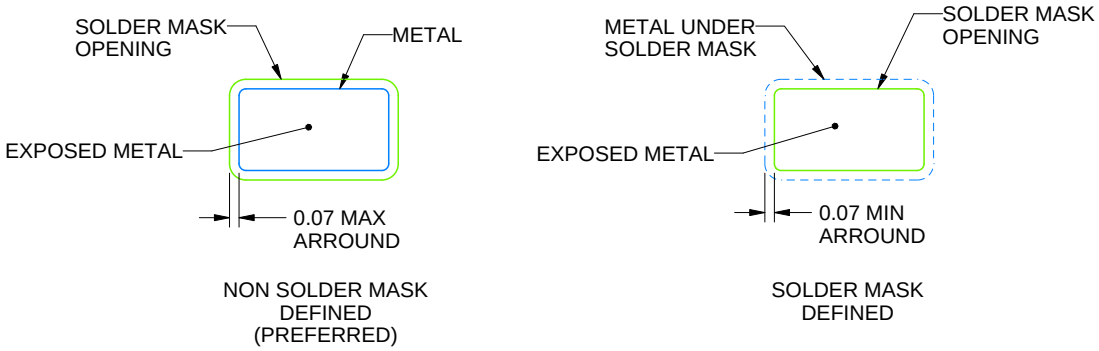
NOTES:

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. Refernce JEDEC MO-203.
4. Support pin may differ or may not be present.
5. Lead width does not comply with JEDEC.
6. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

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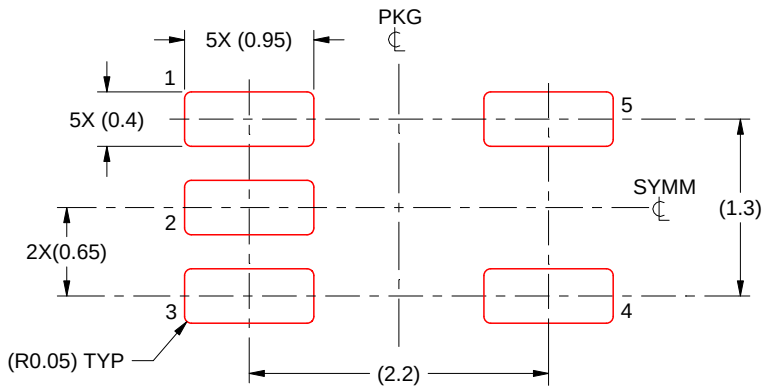
NOTES: (continued)

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



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

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NOTES: (continued)

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

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