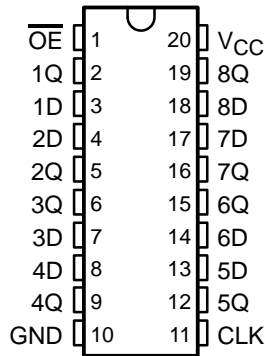


# SN54BCT374, SN74BCT374 OCTAL EDGE-TRIGGERED D-TYPE LATCHES WITH 3-STATE OUTPUTS

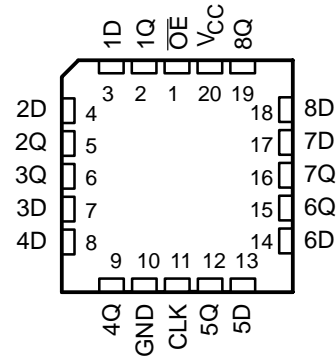
SCBS019C – SEPTEMBER 1988 – REVISED MARCH 2003

- Operating Voltage Range of 4.5 V to 5.5 V
- State-of-the-Art BiCMOS Design Significantly Reduces  $I_{CCZ}$
- Full Parallel Access for Loading
- Buffered Control Inputs
- 3-State Outputs Drive Bus Lines or Buffer Memory Address Registers
- ESD Protection Exceeds JESD 22 – 2000-V Human-Body Model (A114-A)

SN54BCT374 . . . J OR W PACKAGE  
SN74BCT374 . . . DW, N, OR NS PACKAGE  
(TOP VIEW)



SN54BCT374 . . . FK PACKAGE  
(TOP VIEW)



## description/ordering information

These 8-bit flip-flops feature 3-state outputs designed specifically for driving highly capacitive or relatively low-impedance loads. They are particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers.

The eight flip-flops of the 'BCT374 devices are edge-triggered D-type flip-flops. On the positive transition of the clock (CLK) input, the Q outputs are set to the logic levels that were set up at the data (D) inputs.

A buffered output-enable ( $\overline{OE}$ ) input can be used to place the eight outputs in either a normal logic state (high or low) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and the increased drive provide the capability to drive bus lines without need for interface or pullup components. The output-enable ( $\overline{OE}$ ) input does not affect internal operations of the flip-flop. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

## ORDERING INFORMATION

T <sub>A</sub>	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP – N	Tube	SN74BCT374N	SN74BCT374N
	SOIC – DW	Tube	SN74BCT374DW	BCT374
		Tape and reel	SN74BCT374DWR	
	SOP – NS	Tape and reel	SN74BCT374NSR	BCT374
–55°C to 125°C	CDIP – J	Tube	SNJ54BCT374J	SNJ54BCT374J
	CFP – W	Tube	SNJ54BCT374W	SNJ54BCT374W
	LCCC – FK	Tube	SNJ54BCT374FK	SNJ54BCT374FK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# SN54BCT374, SN74BCT374 OCTAL EDGE-TRIGGERED D-TYPE LATCHES WITH 3-STATE OUTPUTS

SCBS019C – SEPTEMBER 1988 – REVISED MARCH 2003

## description/ordering information (continued)

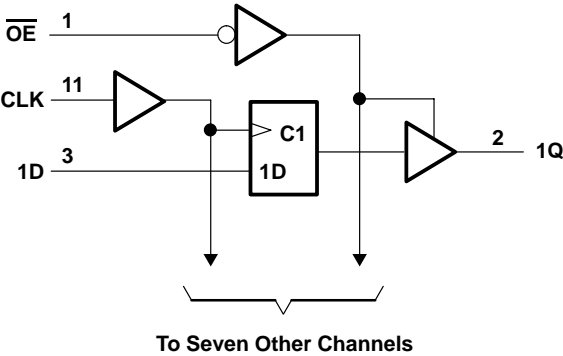
To ensure the high-impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

FUNCTION TABLE

(each flip-flop)

INPUTS			OUTPUT
$\overline{OE}$	CLK	D	Q
L	$\uparrow$	H	H
L	$\uparrow$	L	L
L	H or L	X	$Q_0$
H	X	X	Z

## logic diagram (positive logic)



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, $V_{CC}$	–0.5 V to 7 V
Input voltage range, $V_I$ (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the disabled or power-off state, $V_O$	–0.5 V to 5.5 V
Voltage range applied to any output in the high state, $V_O$	–0.5 V to $V_{CC}$
Input clamp current, $I_{IK}$	–30 mA
Current into any output in the low state: SN54BCT374	96 mA
SN74BCT374	128 mA
Package thermal impedance, $\theta_{JA}$ (see Note 2): DW package	58°C/W
N package	69°C/W
NS package	60°C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C

† 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.

NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.  
2. The package thermal impedance is calculated in accordance with JESD 51-7.

# SN54BCT374, SN74BCT374 OCTAL EDGE-TRIGGERED D-TYPE LATCHES WITH 3-STATE OUTPUTS

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## recommended operating conditions (see Note 3)

		SN54BCT374			SN74BCT374			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.8			0.8	V
$I_{IK}$	Input clamp current			-18			-18	mA
$I_{OH}$	High-level output current			-2			-15	mA
$I_{OL}$	Low-level output current			48			64	mA
$T_A$	Operating free-air temperature	-55		125	0		70	°C

NOTE 3: All unused inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to 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		SN54BCT374			SN74BCT374			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
$V_{IK}$	$V_{CC} = 4.5\text{ V}$ , $I_I = -18\text{ mA}$				-1.2			-1.2	V
$V_{OH}$	$V_{CC} = 4.5\text{ V}$	$I_{OH} = -3\text{ mA}$	2.4	3.3		2.4	3.3		V
		$I_{OH} = -12\text{ mA}$	2	3.2					
		$I_{OH} = -15\text{ mA}$				2	3.1		
$V_{OL}$	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 48\text{ mA}$		0.38	0.55				V
		$I_{OL} = 64\text{ mA}$					0.42	0.55	
$I_I$	$V_{CC} = 5.5\text{ V}$ , $V_I = 5.5\text{ V}$				0.4			0.4	mA
$I_{IH}$	$V_{CC} = 5.5\text{ V}$ , $V_I = 2.7\text{ V}$				20			20	μA
$I_{IL}$	$V_{CC} = 5.5\text{ V}$ , $V_I = 0.5\text{ V}$				-0.6			-0.6	mA
$I_{OS}^\ddagger$	$V_{CC} = 5.5\text{ V}$ , $V_O = 0$		-100		-225	-100		-225	mA
$I_{OZH}$	$V_{CC} = 5.5\text{ V}$ , $V_O = 2.7\text{ V}$				50			50	μA
$I_{OZL}$	$V_{CC} = 5.5\text{ V}$ , $V_O = 0.5\text{ V}$				-50			-50	μA
$I_{CCL}$	$V_{CC} = 5.5\text{ V}$				37			37	mA
$I_{CCH}$	$V_{CC} = 5.5\text{ V}$				2			2	mA
$I_{CCZ}$	$V_{CC} = 5.5\text{ V}$				5			5	mA
$C_i$	$V_{CC} = 5\text{ V}$ , $V_I = 2.5\text{ V or }0.5\text{ V}$				6			6	pF
$C_o$	$V_{CC} = 5\text{ V}$ , $V_O = 2.5\text{ V or }0.5\text{ V}$				10			10	pF

† All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

‡ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.



# SN54BCT374, SN74BCT374

## OCTAL EDGE-TRIGGERED D-TYPE LATCHES

### WITH 3-STATE OUTPUTS

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timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

			V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C		SN54BCT374		SN74BCT374		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency		70		70		70		MHz
t <sub>w</sub>	Pulse duration	CLK high	7		8		7		ns
t <sub>su</sub>	Setup time before CLK↑	Data high or low	6.5		6.5		6.5		ns
t <sub>h</sub>	Hold time after CLK↑	Data high or low	0		0		0		ns

### switching characteristics (see Figure 1)

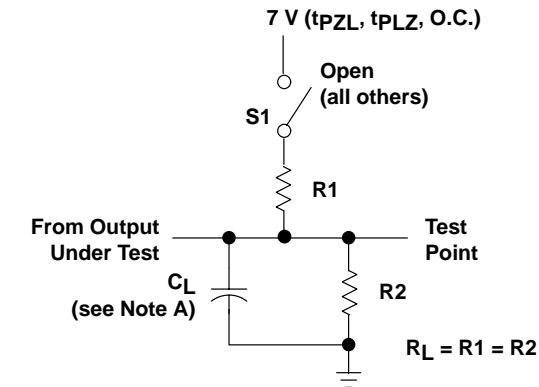
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = 25°C			V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†				UNIT
			'BCT374			SN54BCT374		SN74BCT374		
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f <sub>max</sub>			70			70		70		MHz
t <sub>PLH</sub>	CLK	Q	2	7.2	9.1	2	11.6	2	10.6	ns
t <sub>PHL</sub>			2	7.1	8.8	2	10.6	2	10	
t <sub>PZH</sub>	OE	Q	1	8.3	10.1	1	12.7	1	12.3	ns
t <sub>PZL</sub>			1	8.6	10.6	1	13	1	12.7	
t <sub>PHZ</sub>	OE	Q	1	4.7	6.3	1	7.1	1	6.8	ns
t <sub>PLZ</sub>			1	4.8	6.3	1	7.5	1	6.8	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

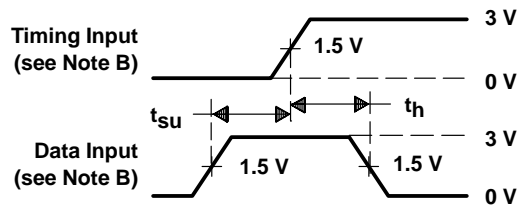
# SN54BCT374, SN74BCT374 OCTAL EDGE-TRIGGERED D-TYPE LATCHES WITH 3-STATE OUTPUTS

SCBS019C – SEPTEMBER 1988 – REVISED MARCH 2003

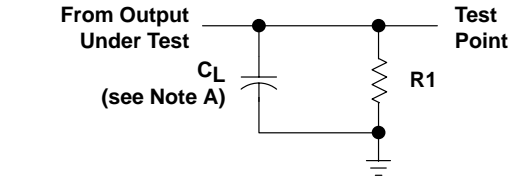
## PARAMETER MEASUREMENT INFORMATION



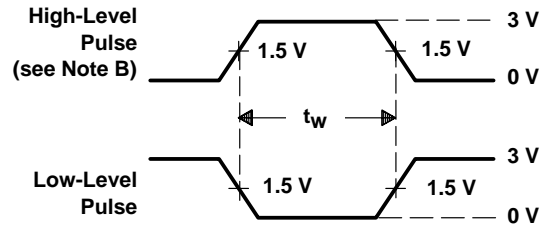
LOAD CIRCUIT FOR  
3-STATE AND OPEN-COLLECTOR OUTPUTS



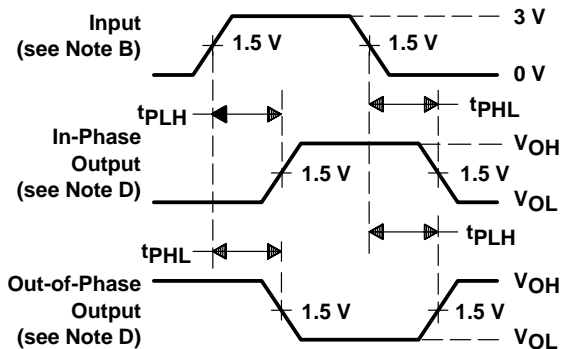
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



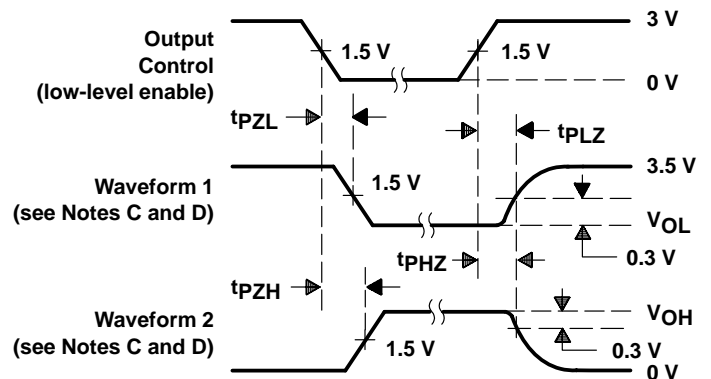
LOAD CIRCUIT FOR  
TOTEM-POLE OUTPUTS



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES (see Note D)



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

- NOTES:
- $C_L$  includes probe and jig capacitance.
  - All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $t_r = t_f \leq 2.5$  ns, duty cycle = 50%.
  - 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.
  - The outputs are measured one at a time with one transition per measurement.
  - When measuring propagation delay times of 3-state outputs, switch S1 is open.
  - All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

## 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
5962-9051601M2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-9051601M2A SNJ54BCT 374FK	<a href="#">Samples</a>
5962-9051601MRA	ACTIVE	CDIP	J	20	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-9051601MR A SNJ54BCT374J	<a href="#">Samples</a>
5962-9051601MSA	ACTIVE	CFP	W	20	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-9051601MS A SNJ54BCT374W	<a href="#">Samples</a>
SN74BCT374DBR	ACTIVE	SSOP	DB	20	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	BT374	<a href="#">Samples</a>
SN74BCT374DW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	BCT374	<a href="#">Samples</a>
SN74BCT374N	ACTIVE	PDIP	N	20	20	Pb-Free (RoHS)	NIPDAU	N / A for Pkg Type	0 to 70	SN74BCT374N	<a href="#">Samples</a>
SN74BCT374NE4	ACTIVE	PDIP	N	20	20	Pb-Free (RoHS)	NIPDAU	N / A for Pkg Type	0 to 70	SN74BCT374N	<a href="#">Samples</a>
SN74BCT374NSR	ACTIVE	SO	NS	20	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	0 to 70	BCT374	<a href="#">Samples</a>
SNJ54BCT374FK	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-9051601M2A SNJ54BCT 374FK	<a href="#">Samples</a>
SNJ54BCT374J	ACTIVE	CDIP	J	20	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-9051601MR A SNJ54BCT374J	<a href="#">Samples</a>
SNJ54BCT374W	ACTIVE	CFP	W	20	1	TBD	Call TI	N / A for Pkg Type	-55 to 125	5962-9051601MS A SNJ54BCT374W	<a href="#">Samples</a>

(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.

<sup>(2)</sup> **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  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

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

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

<sup>(5)</sup> 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.

<sup>(6)</sup> 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 SN54BCT374, SN74BCT374 :**

- Catalog: [SN74BCT374](#)
- Military: [SN54BCT374](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

**TAPE AND REEL INFORMATION**


\*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
SN74BCT374DBR	SSOP	DB	20	2000	330.0	16.4	8.2	7.5	2.5	12.0	16.0	Q1
SN74BCT374NSR	SO	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	24.0	Q1



## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74BCT374DBR	SSOP	DB	20	2000	367.0	367.0	38.0
SN74BCT374NSR	SO	NS	20	2000	367.0	367.0	45.0

W (R-GDFP-F20)

CERAMIC DUAL FLATPACK



## NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. This package can be hermetically sealed with a ceramic lid using glass frit.
- D. Index point is provided on cap for terminal identification only.
- E. Falls within Mil-Std 1835 GDFP2-F20

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

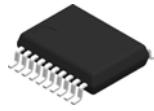


NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004



4214851/B 08/2019

## 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. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-150.

# EXAMPLE BOARD LAYOUT

DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4214851/B 08/2019

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

DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4214851/B 08/2019

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.

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/C 03/03

- 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, not to exceed 0,15.

J (R-GDIP-T\*\*)

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.



## N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE

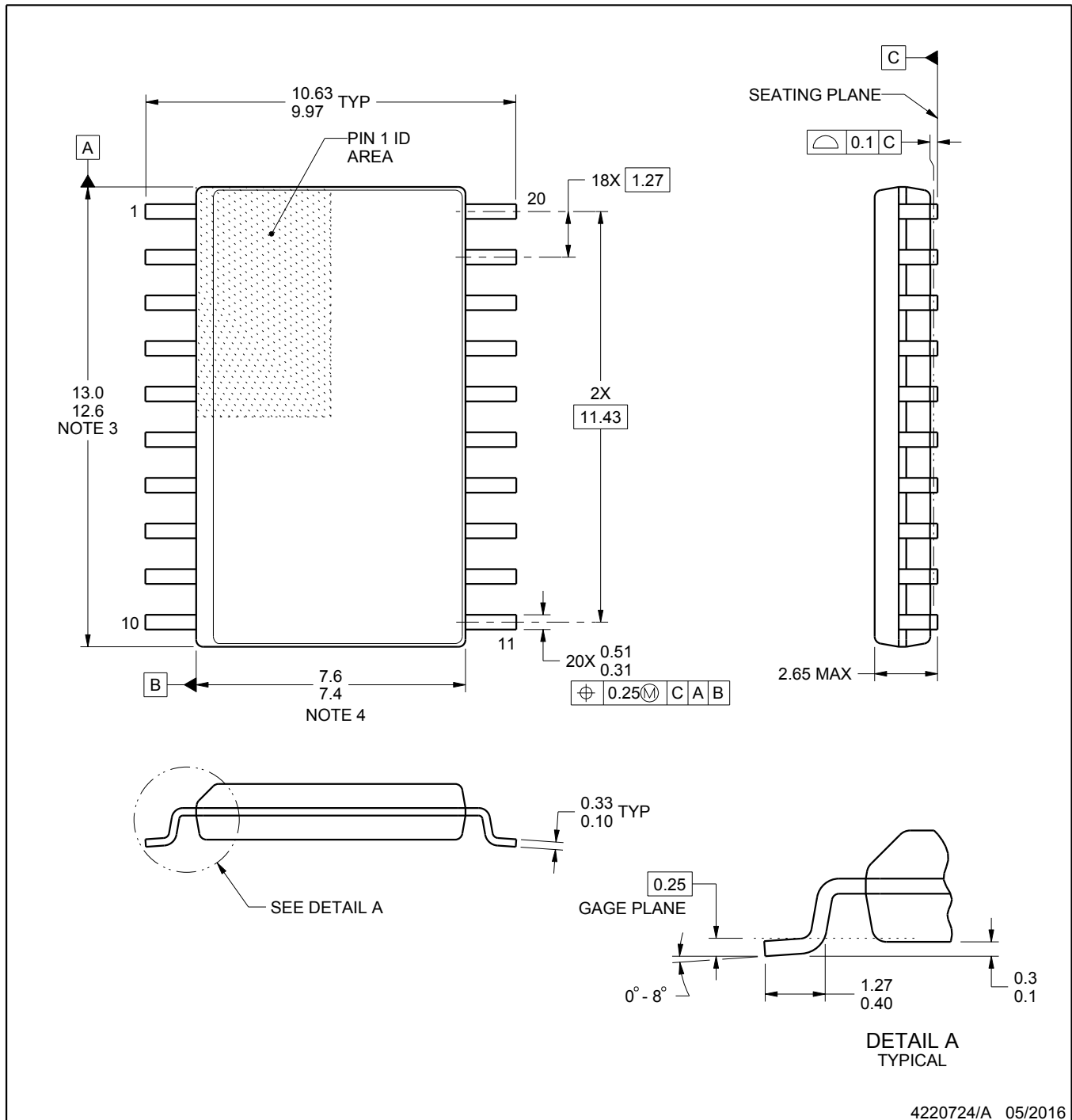


PINS **	14	16	18	20
DIM				
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD



4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.



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## NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.

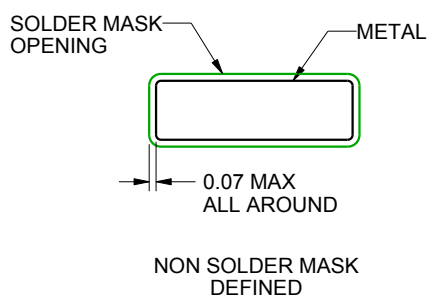
**DW0020A**

### SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:6X



## SOLDER MASK DETAILS

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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

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:6X

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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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