SNx4HC640 Octal Bus Transceivers With 3-State Outputs

1 Features

- Wide operating voltage range of 2V to 6V
- High-Current 3-state outputs can drive up to 10 LSTTL loads
- Low power consumption, 80-µA max I_{CC}
- Typical t_{pd} = 8ns
- ±4-mA output drive at 5V
- Low input current of 1µA max
- Inverting logic

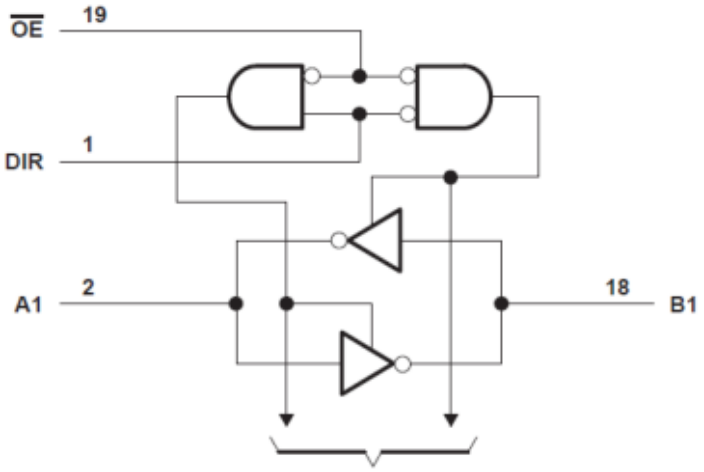
2 Description

The SNx4HC640 is an octal bus transceiver with 3-state outputs. All eight channels are controlled by the direction (DIR) pin and output enable $\overline{OE}$ pin.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SN54HC640	J (CDIP, 20)	26.92 mm × 6.92 mm
SN74HC640	DW (SOIC, 20)	12.80 mm × 7.50 mm
	N (PDIP, 20)	25.40 mm × 6.35 mm
	NS (SO, 20)	15.00 mm × 5.30 mm
	PW (TSSOP, 20)	4.40 mm × 6.50 mm

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



Pinout
Top View

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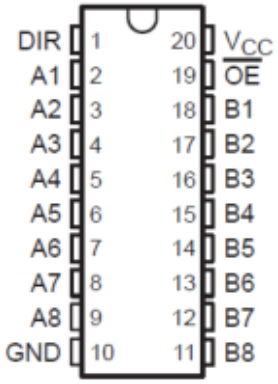
3 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (August 2003) to Revision E (September 2022)	Page
• Updated the numbering, formatting, tables, figures, and cross-references throughout the document to reflect modern data sheet standards	1

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4 Pin Configuration and Functions



J, DW, N, NS, or PW Package
20-Pin CDIP, SOIC, PDIP, SO, TSSOP
Top View

5 Specifications

5.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		-0.5	7	V
I_{IK}	Input clamp current(2)	(V_I < 0 or V_I > V_{CC})		±20	mA
I_{OK}	Output clamp current(2)	(V_O < 0 or V_O > V_{CC})		±20	mA
I_O	Continuous output current	(V_O = 0 to V_{CC})		±35	mA
V_{CC} or GND	Continuous current through			±70	mA
T_J	Junction temperature			150	°C
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 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 and output voltage ratings may be exceeded if the input and output current ratings are observed.

5.2 Recommended Operating Conditions(1)

			SN54HC640			SN74HC640			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		2	5	6	2	5	6	V
V_{IH}	High-level input voltage	V_{CC} = 2 V	1.5			1.5			V
		V_{CC} = 4.5 V	3.15			3.15			
		V_{CC} = 6 V	4.2			4.2			
V_{IL}	Low-level input voltage	V_{CC} = 2 V			0.5			0.5	V
		V_{CC} = 4.5 V			1.35			1.35	
		V_{CC} = 6 V			1.8			1.8	
V_I	Input voltage		0		V_{CC}	0		V_{CC}	V
V_O	Output voltage		0		V_{CC}	0		V_{CC}	V
Δt/Δv	Input transition rise/fall time	V_{CC} = 2 V			1000			1000	ns
		V_{CC} = 4.5 V			500			500	
		V_{CC} = 6 V			400			400	
T_A	Operating free-air temperature		– 55		125	– 40		85	°C

(1) 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 SMOS Inputs, literature number SCBA004.

5.3 Thermal Information

THERMAL METRIC(1)		DW (SOIC) 20 PINS	N (PDIP) 20 PINS	NS (SO) 20 PINS	PW (TSSOP) 20 PINS	UNIT
$R_{θJA}$	Package thermal impedance	58	69	60	83	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC package thermal metrics* application report.

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5.4 Electrical Characteristics

PARAMETER			TEST CONDITIONS(1)	V_{CC} (V)	T_A = 25°C			SN54HC640		SN74HC640		UNIT
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	High-level output voltage		I_{OH} = –20 µA	2	1.9	1.998		1.9		1.9		V
				4.5	4.4	4.400		4.4		4.4		
				6	5.9	5.999		5.9		5.9		
			I_{OH} = –6 mA	4.5	3.98	4.3		3.7		3.84		
			I_{OH} = –7.8 mA	6	5.48	5.8		5.2		5.34		
V_{OL}	Low-level output voltage		I_{OL} = 20 µA	2		0.002	0.1		0.1		0.1	V
				4.5		0.001	0.1		0.1		0.1	
				6		0.001	0.1		0.1		0.1	
			I_{OL} = 6 mA	4.5		0.17	0.26		0.4		0.33	
			I_{OL} = 7.8 mA	6		0.15	0.26		0.4		0.33	
I_I	Input hold current	DIR or $\overline{OE}$	V_I = V_{CC} or 0	6			±0.1		±1000		±1000	nA
I_{OZ}	Off-state output current	A or B	V_I = V_{CC} or 0. I_O = 0	6			±0.01		±10		±5	µA
ΔI_{CC}	Supply-current change		One input at 0.5V or 2.4 V, Other inputs at 0 or V_{CC}	6			8		160		80	µA
C_i	Input capacitance	DIR or $\overline{OE}$		2 to 6		3	10		10		10	pF

(1) V_I = V_{IH} or V_{IL}, unless otherwise noted.

5.5 Switching Characteristics

C_L = 50 pF. See Figure 6

PARAMETER		FROM (INPUT)	TO (OUTPUT)	V_{CC} (V)	T_A = 25°C			SN54HC640		SN75HC640		
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	Propagation delay	A or B	Y	2		29	105		160		130	ns
				4.5		10	21		32		26	
				6		8	18		27		22	
t_{en}	Enable time	$\overline{OE}$	A or B	2		109	230		340		290	ns
				4.5		27	46		68		58	
				6		20	39		58		49	
t_{dis}	Disable time	$\overline{OE}$	A or B	2		40	150		225		190	ns
				4.5		18	30		45		38	
				6		16	26		38		32	
t_t	Transition time		A or B	2		20	60		90		75	ns
				4.5		8	12		18		15	
				6		6	10		15		13	

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5.5 Switching Characteristics

C_L = 150 pF. See Figure 6

PARAMETER		FROM (INPUT)	TO (OUTPUT)	V_{CC} (V)	T_A = 25°C			SN54HC640		SN75HC640		
					MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	Propagation delay	A or B	B or A	2		44	190		290		235	ns
				4.5		14	38		58		47	
				6		11	33		49		41	
t_{en}	Enable time	$\overline{OE}$	A or B	2		124	315		470		395	ns
				4.5		31	63		94		79	
				6		23	54		80		68	
t_t	Transition time		A or B	2		45	210		315		265	ns
				4.5		17	42		63		53	
				6		13	36		53		45	

5.6 Operating Characteristics

T_A = 25°C

		Test Conditions	TYP	UNIT
C_{pd}	Power dissipation capacitance	No load	40	pF

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6 Parameter Measurement Information

t_{pd} is the maximum between t_{PLH} and t_{PHL}

t_t is the maximum between t_{TLH} and t_{THL}

$t_{dis}$is the maximum between t_{PLZ} and t_{PHZ}

t_{en} is the maximum between t_{PZL} and t_{PZH}

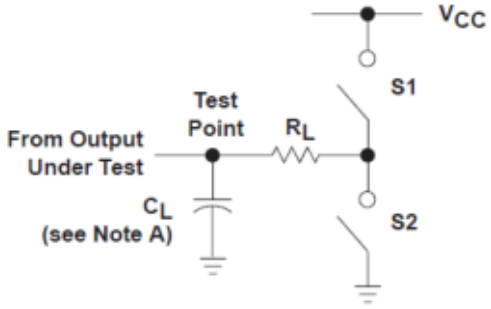


Figure 6-1. Load Circuit

PARAMETER		R_L	C_L	S1	S2
t_{en}	t_{PZH}	1 kΩ	50 pF or 150 pF	Open	Closed
	t_{PZL}			Closed	Open
t_{dis}	t_{PHZ}	1 kΩ	50 pF	Open	Closed
	t_{PLZ}			Closed	Open
t_{pd} or t_t		--	50 pF or 150 pF	Open	Open

Figure 6-2.

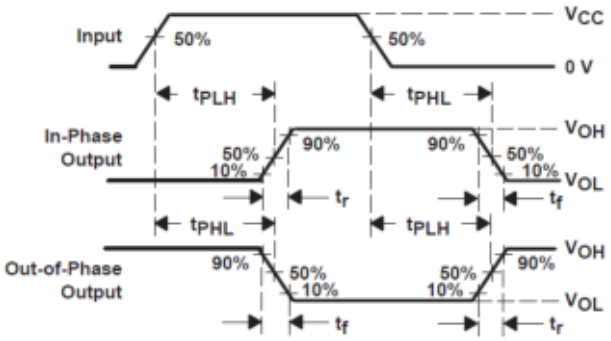


Figure 6-3. Voltage Waveforms
Propagation Delay and Output Transition Times

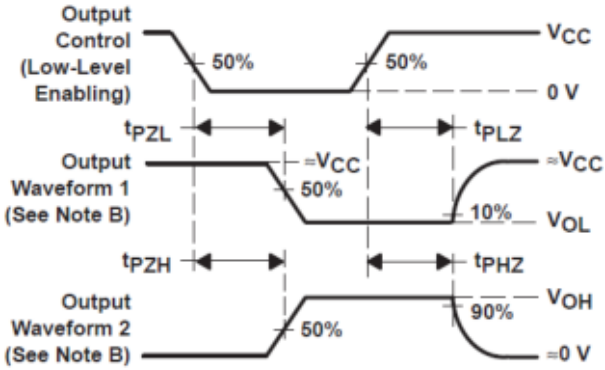


Figure 6-4. Voltage Waveforms
Enable and Disable Times for 3-State Outputs

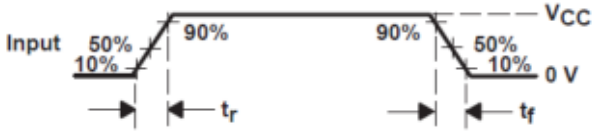


Figure 6-5. Voltage Wavefroms
Propagation Delay and Output Transition Times

A. C_L includes probe and test-fixture 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. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_r = 6 ns, t_f = 6 ns.

D. The outputs are measured one at a time with one input transition per measurement.

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7 Detailed Description

7.1 Overview

These octal bus transceivers are designed for asynchronous two-way communication between data buses. These devices transmit data from the A bus to the B bus or from the B bus to the A bus, depending upon the level at the direction-control (DIR) input. The output-enable ($\overline{OE}$) input can be used to disable the device so the buses are effectively isolated.

7.2 Functional Block Diagram

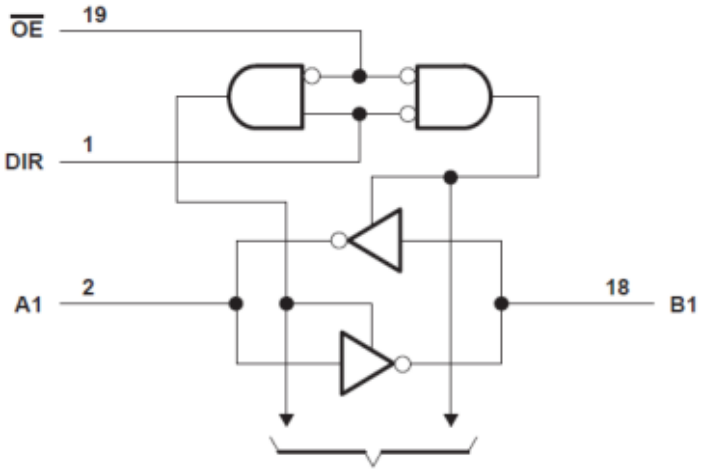


Figure 7-1. Functional Block Diagram

7.3 Device Functional Modes

Table 7-1. Function Table (each transceiver)

INPUTS(1)		Operation
$\overline{OE}$	DIR	
L	L	$\overline{B}$ data to A bus
L	H	$\overline{A}$ data to B bus
H	X	Isolation

(1) H = High Voltage Level, L = Low Voltage Level, X = Don't Care

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8 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. A 0.1-µF capacitor is recommended for this device. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1-µF and 1-µF capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

9 Layout

9.1 Layout Guidelines

When using multiple-input and multiple-channel logic devices inputs must not ever be left floating. 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 3 of the 4 buffer gates are used. Such unused input pins must not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. All unused inputs of digital logic devices must be connected to a logic high or logic low voltage, as defined by the input voltage specifications, to prevent them from floating. The logic level that must be applied to any particular unused input depends on the function of the device. Generally, the inputs are tied to GND or V_{CC}, whichever makes more sense for the logic function or is more convenient.

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10 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

10.1 Documentation Support

10.1.1 Related Documentation

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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All trademarks are the property of their respective owners.

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.

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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)
5962-8780901RA	Active	Production	CDIP (J) | 20	20 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-8780901RA SNJ54HC640J
SN54HC640J	Active	Production	CDIP (J) | 20	20 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN54HC640J
SN54HC640J.A	Active	Production	CDIP (J) | 20	20 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	SN54HC640J
SN74HC640DW	Obsolete	Production	SOIC (DW) | 20	-	-	Call TI	Call TI	-40 to 85	HC640
SN74HC640DWR	Active	Production	SOIC (DW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC640
SN74HC640DWR.A	Active	Production	SOIC (DW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC640
SN74HC640N	Active	Production	PDIP (N) | 20	20 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 85	SN74HC640N
SN74HC640N.A	Active	Production	PDIP (N) | 20	20 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 85	SN74HC640N
SN74HC640NSR	Active	Production	SOP (NS) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC640
SN74HC640NSR.A	Active	Production	SOP (NS) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC640
SN74HC640PW	Obsolete	Production	TSSOP (PW) | 20	-	-	Call TI	Call TI	-40 to 85	HC640
SN74HC640PWR	Active	Production	TSSOP (PW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC640
SN74HC640PWR.A	Active	Production	TSSOP (PW) | 20	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC640
SNJ54HC640J	Active	Production	CDIP (J) | 20	20 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-8780901RA SNJ54HC640J
SNJ54HC640J.A	Active	Production	CDIP (J) | 20	20 | TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-8780901RA SNJ54HC640J

(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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and 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 SN54HC640, SN74HC640 :

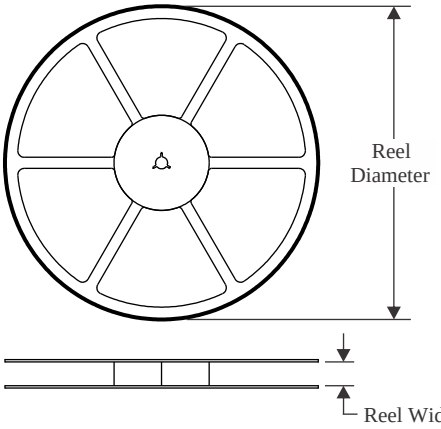
- Catalog : SN74HC640
- Military : SN54HC640

NOTE: Qualified Version Definitions:

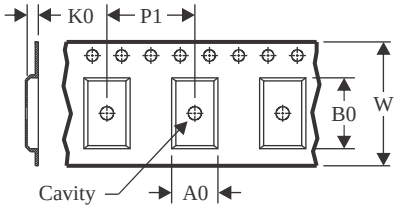
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

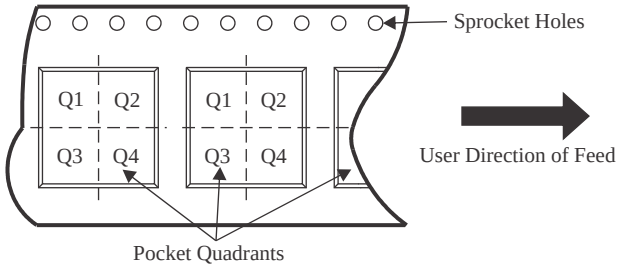


TAPE DIMENSIONS



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

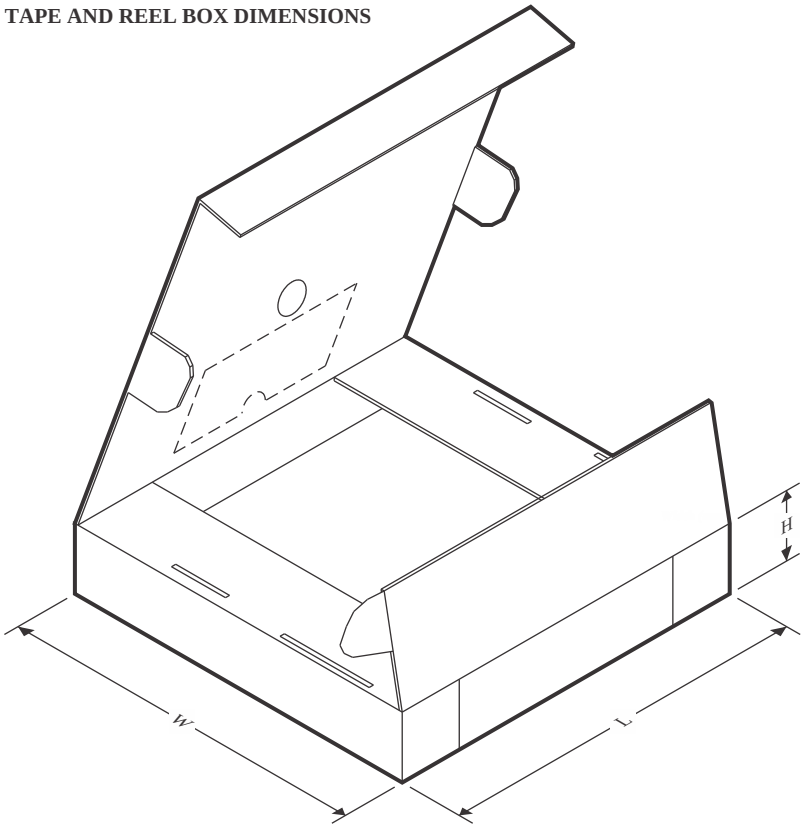
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74HC640DWR	SOIC	DW	20	2000	330.0	24.4	10.9	13.3	2.7	12.0	24.0	Q1
SN74HC640DWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.3	2.7	12.0	24.0	Q1
SN74HC640NSR	SOP	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	24.0	Q1
SN74HC640PWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1

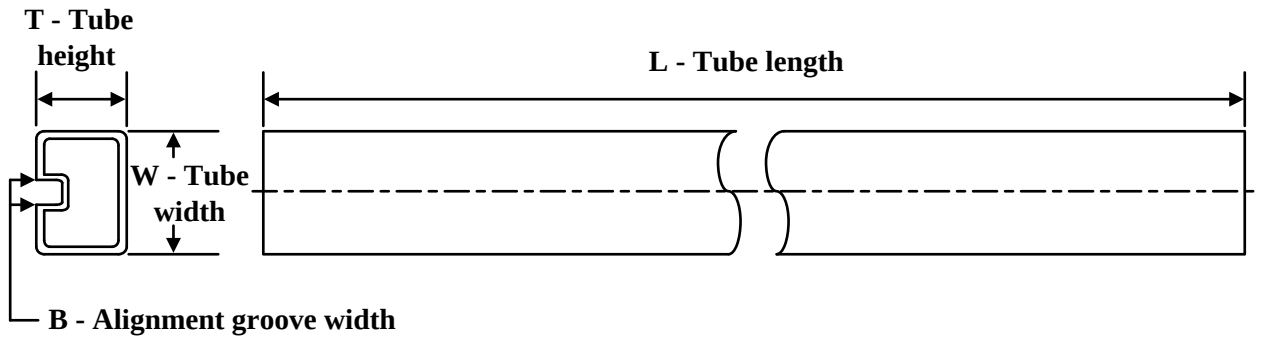
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74HC640DWR	SOIC	DW	20	2000	356.0	356.0	45.0
SN74HC640DWR	SOIC	DW	20	2000	356.0	356.0	45.0
SN74HC640NSR	SOP	NS	20	2000	356.0	356.0	45.0
SN74HC640PWR	TSSOP	PW	20	2000	353.0	353.0	32.0

TUBE



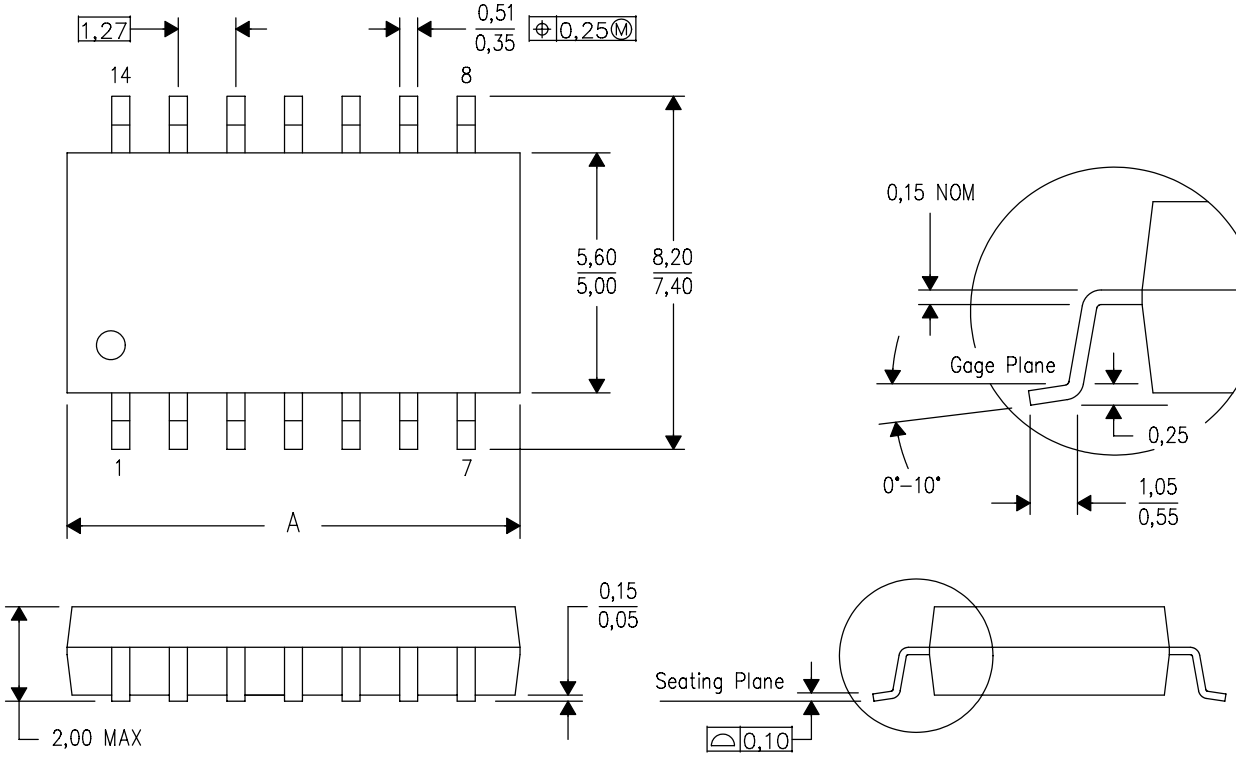
*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
SN74HC640N	N	PDIP	20	20	506	13.97	11230	4.32
SN74HC640N.A	N	PDIP	20	20	506	13.97	11230	4.32

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

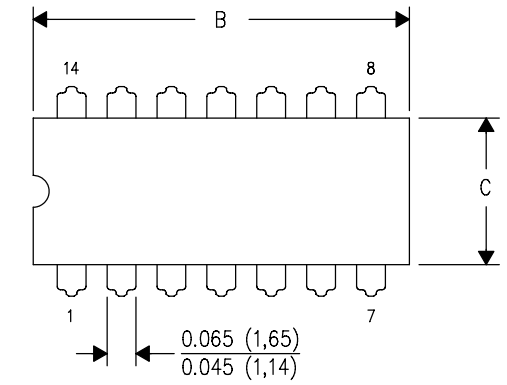
4040062/C 03/03

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.

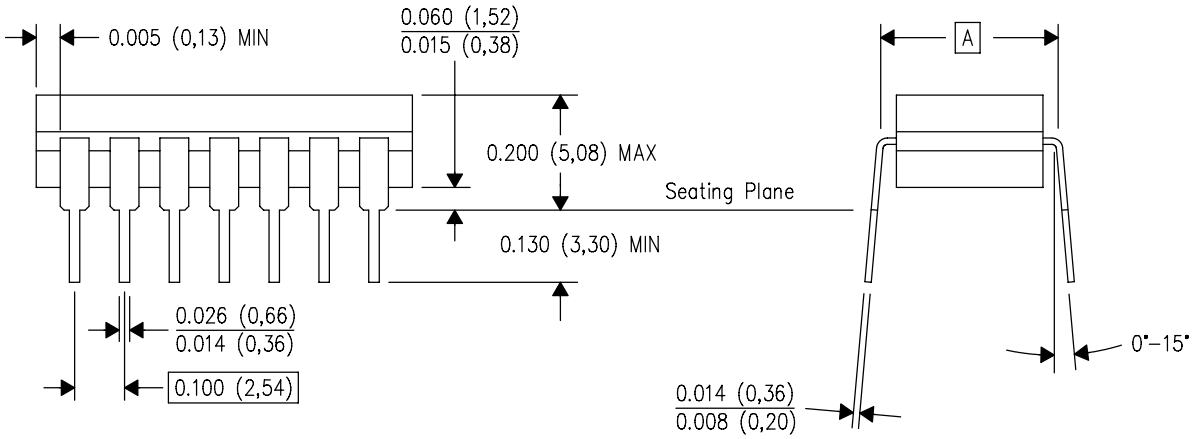
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



DIM \ PINS **	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)



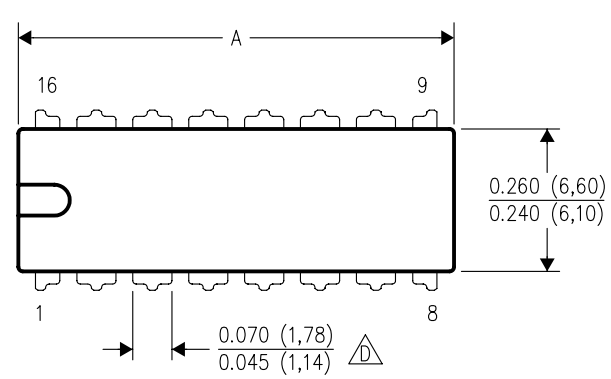
4040083/F 03/03

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.

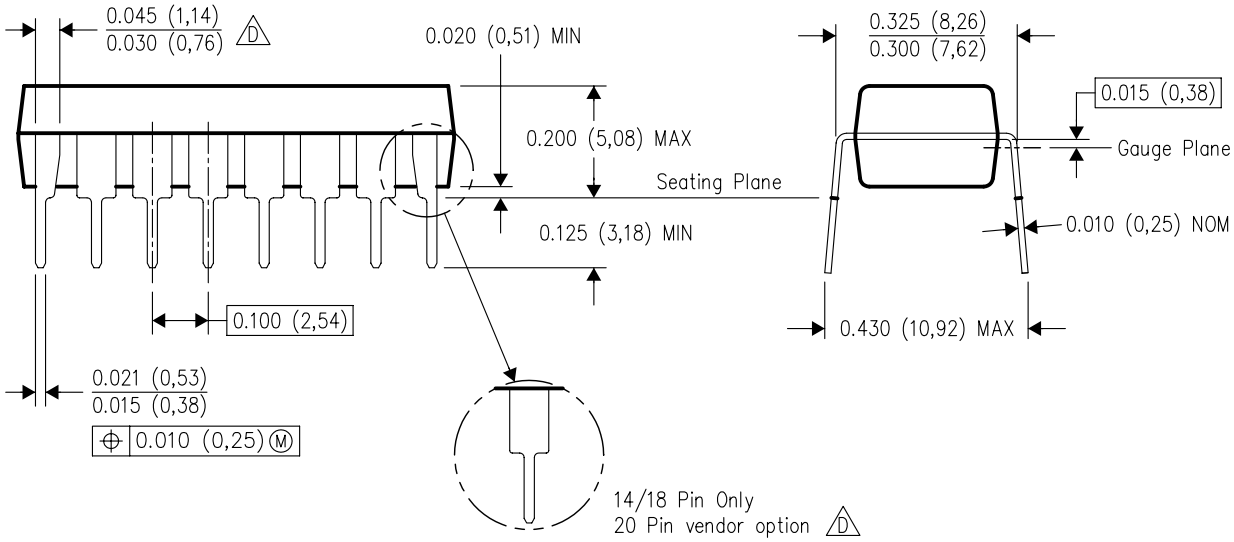
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
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 (C)	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.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

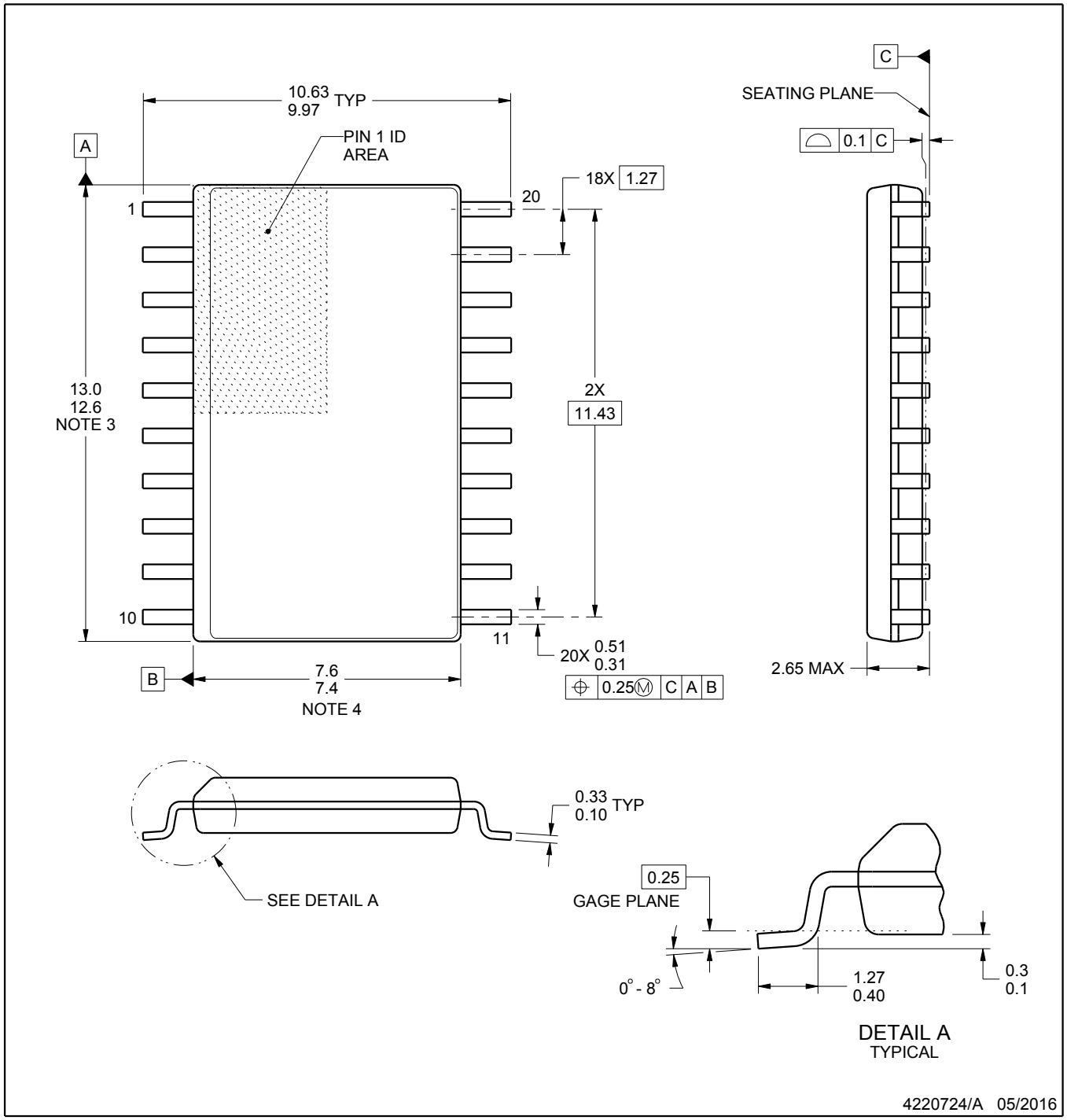


PACKAGE OUTLINE

DW0020A

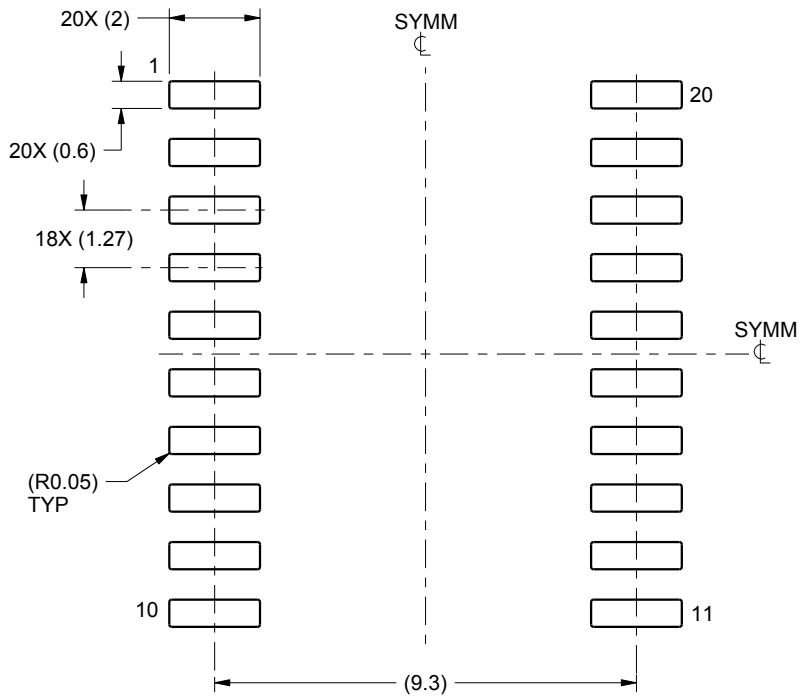
SOIC - 2.65 mm max height

SOIC

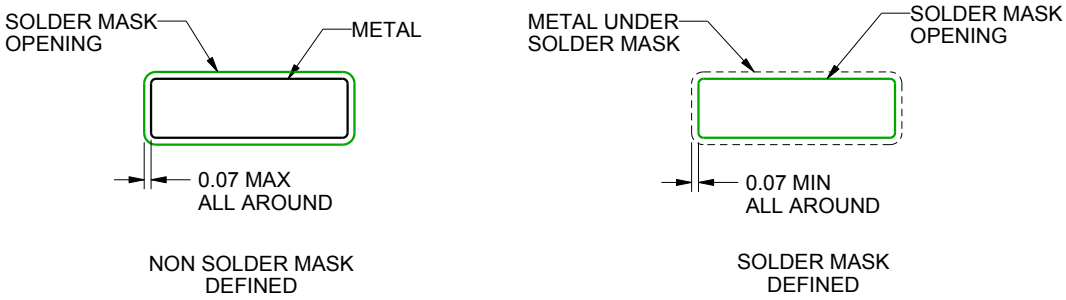


NOTES:

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.



LAND PATTERN EXAMPLE
SCALE:6X

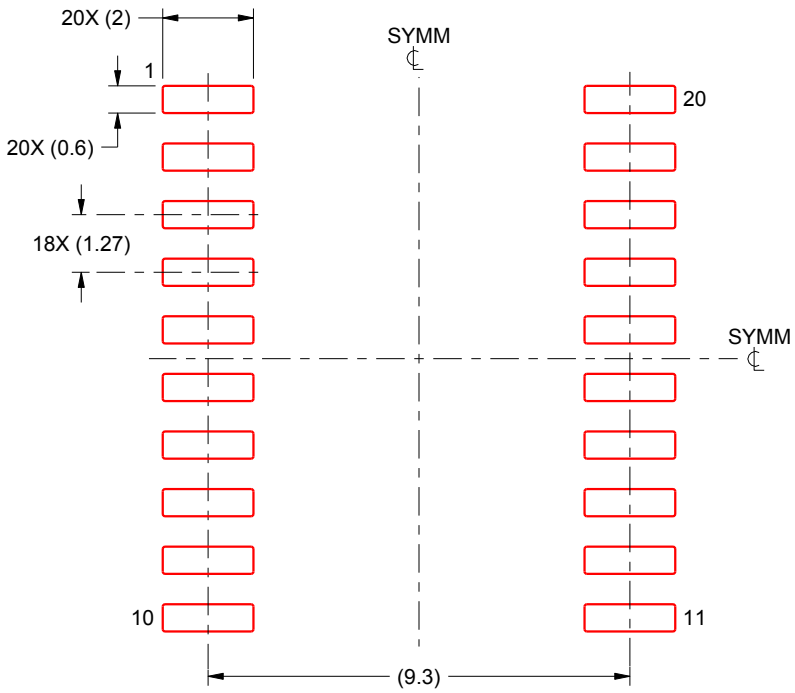


SOLDER MASK DETAILS

4220724/A 05/2016

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.



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

4220724/A 05/2016

NOTES: (continued)

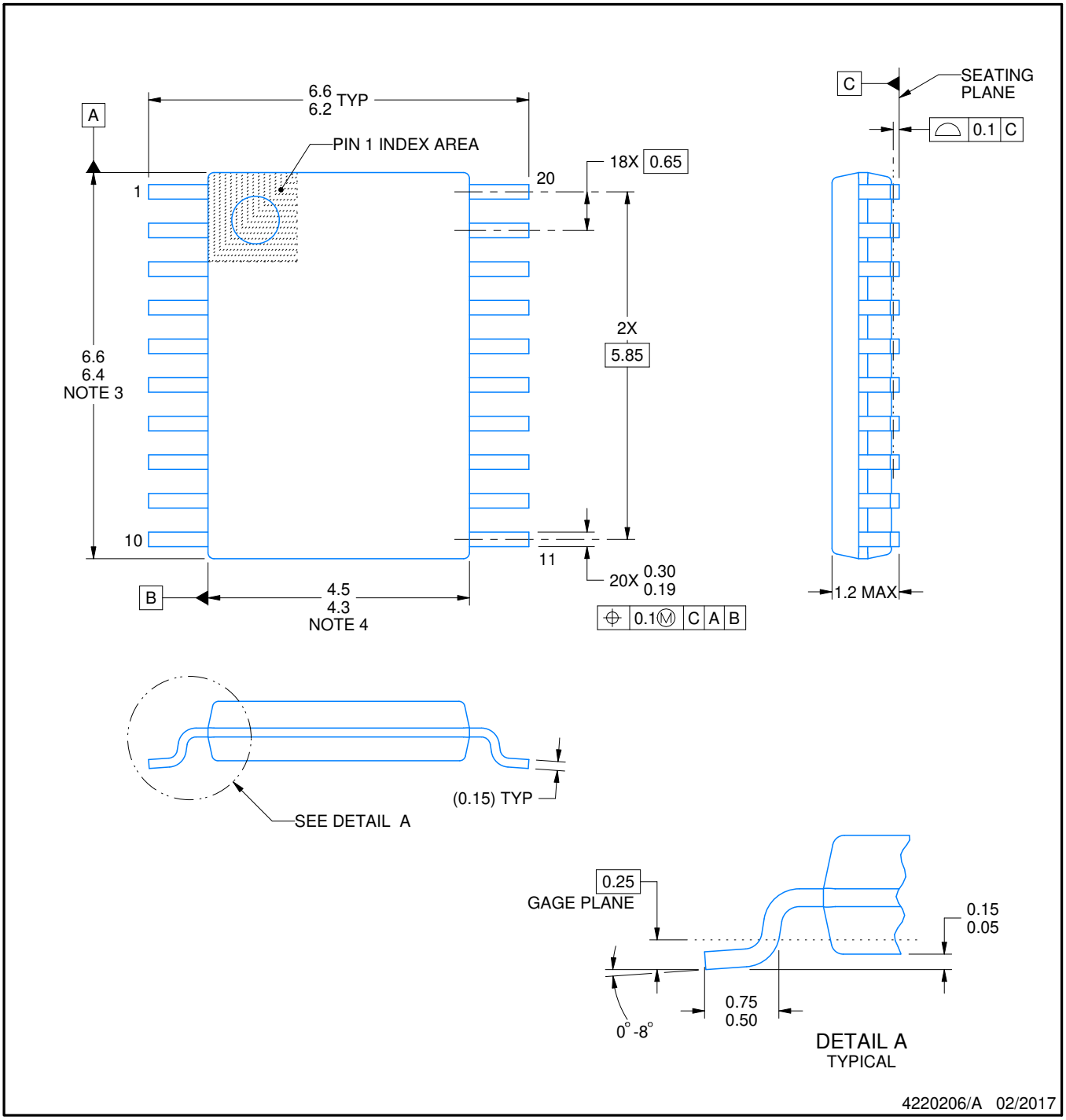
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

PW0020A

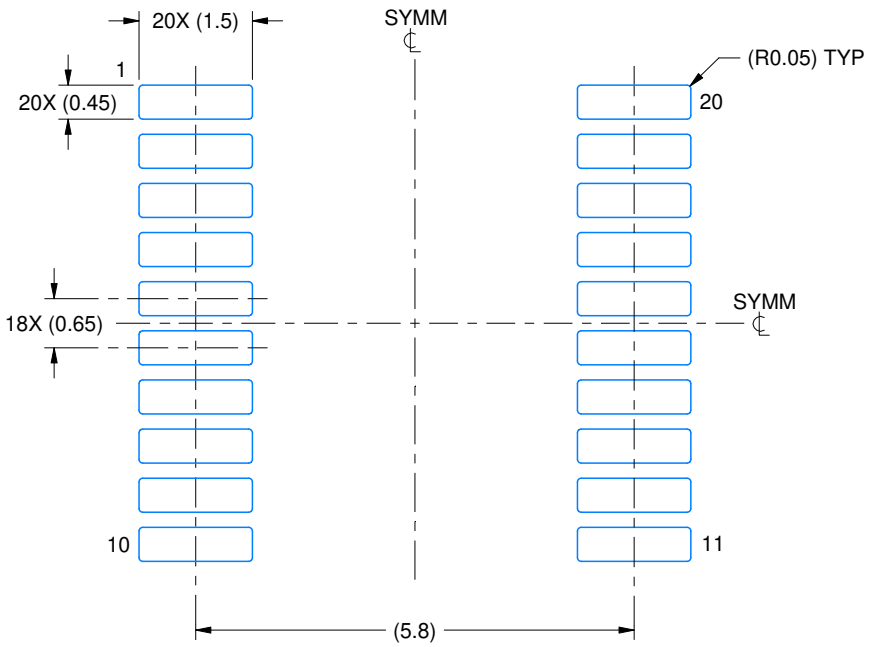
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

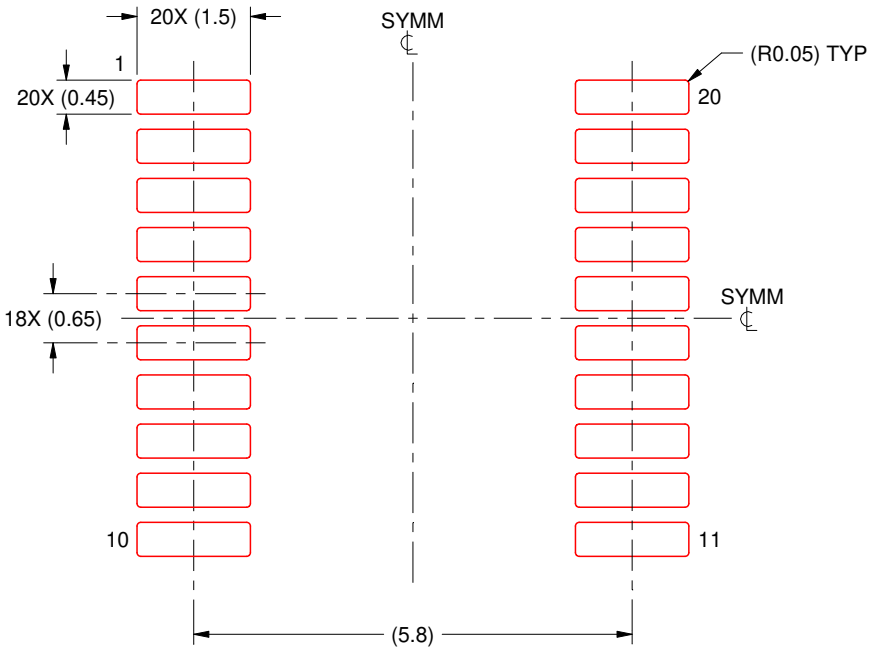


SOLDER MASK DETAILS

4220206/A 02/2017

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.



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

4220206/A 02/2017

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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