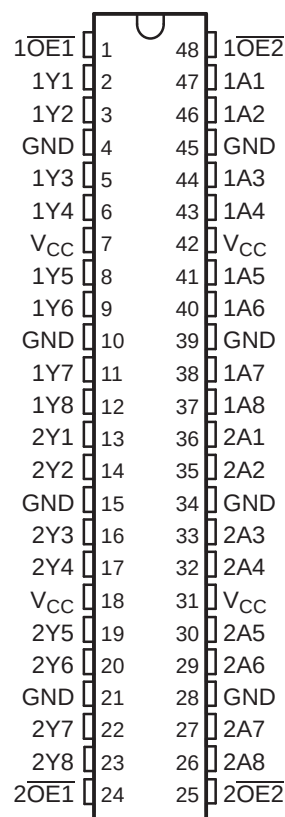


FEATURES

- Members of the Texas Instruments Widebus™ Family
- State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})
- Support Unregulated Battery Operation Down to 2.7 V
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- I_{off} and Power-Up 3-State Support Hot Insertion
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise
- Flow-Through Architecture Optimizes PCB Layout
- Latch-Up Performance Exceeds 500 mA Per JESD 17
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ($C = 200$ pF, $R = 0$)
- Package Options Include Plastic Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings

SN54LVTH16541 . . . WD PACKAGE
SN74LVTH16541 . . . DGG OR DL PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

These 16-bit buffers/drivers are designed specifically for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

These devices are noninverting 16-bit buffers composed of two 8-bit sections with separate output-enable signals. For either 8-bit buffer section, the two output-enable ($1OE1$ and $1OE2$ or $2OE1$ and $2OE2$) inputs must be low for the corresponding Y outputs to be active. If either output-enable input is high, the outputs of that 8-bit buffer section are in the high-impedance state.

When V_{CC} is between 0 and 1.5 V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, $\overline{OE}$ 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.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

These devices are fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.



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.

Widebus is a trademark of Texas Instruments.

SN54LVTH16541, SN74LVTH16541

3.3-V ABT 16-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

SCBS691E – MAY 1997 – REVISED NOVEMBER 2006

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The SN54LVTH16541 is characterized for operation over the full military temperature range of -55°C to 125°C .
The SN74LVTH16541 is characterized for operation from -40°C to 85°C .

ORDERING INFORMATION

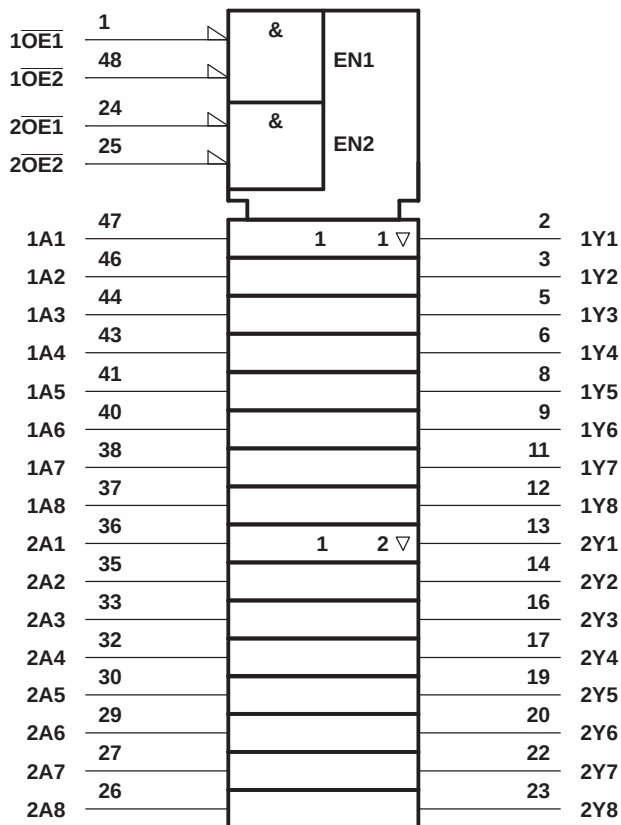
T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SSOP – DL	Reel of 1000	74LVTH16541DLRG4	LVTH16541
			SN74LVTH16541DLR	
		Tube of 25	SN74LVTH16541DL	
			SN74LVTH16541DLG4	
	TSSOP – DGG	Reel of 2000	74LVTH16541DGGRE4	LVTH16541
			SN74LVTH16541DGGR	

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

FUNCTION TABLE (each 8-bit section)

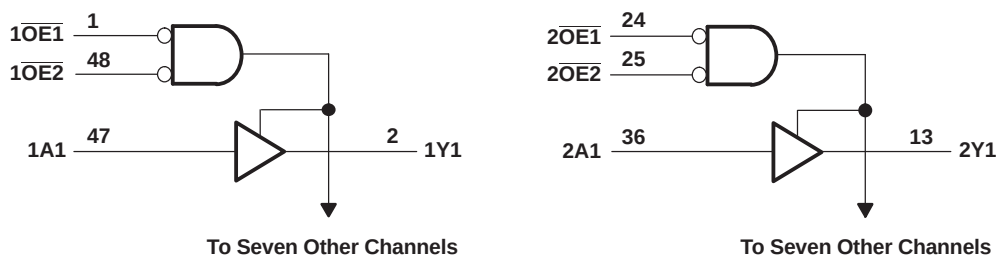
INPUTS			OUTPUT Y
$\overline{\text{OE1}}$	$\overline{\text{OE2}}$	A	
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

LOGIC SYMBOL ⁽¹⁾



(1) This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

LOGIC DIAGRAM (POSITIVE LOGIC)



SN54LVTH16541, SN74LVTH16541

3.3-V ABT 16-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

SCBS691E – MAY 1997 – REVISED NOVEMBER 2006

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	7	V
V_O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾	–0.5	7	V
V_O	Voltage range applied to any output in the high state ⁽²⁾	–0.5	$V_{CC} + 0.5$	V
I_O	Current into any output in the low state	SN54LVTH16541	96	mA
		SN74LVTH16541	128	
I_O	Current into any output in the high state ⁽³⁾	SN54LVTH16541	48	mA
		SN74LVTH16541	64	
I_{IK}	Input clamp current	$V_I < 0$	–50	mA
I_{OK}	Output clamp current	$V_O < 0$	–50	mA
θ_{JA}	Package thermal impedance ⁽⁴⁾	DGG package	89	°C/W
		DL package	94	
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 and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

(3) This current flows only when the output is in the high state and $V_O > V_{CC}$.

(4) The package thermal impedance is calculated in accordance with JESD 51.

Recommended Operating Conditions⁽¹⁾

		SN54LVTH16541		SN74LVTH16541		UNIT
		MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	2.7	3.6	2.7	3.6	V
V_{IH}	High-level input voltage	2		2		V
V_{IL}	Low-level input voltage		0.8		0.8	V
V_I	Input voltage		5.5		5.5	V
I_{OH}	High-level output current		–24		–32	mA
I_{OL}	Low-level output current		48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate		10		10	ns/V
	Outputs enabled					
$\Delta t/\Delta V_{CC}$	Power-up ramp rate	200		200		µs/V
T_A	Operating free-air temperature	–55	125	–40	85	°C

(1) All unused control 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		SN54LVTH16541			SN74LVTH16541B			UNIT
				MIN	TYP ⁽¹⁾	MAX	MIN	TYP ⁽¹⁾	MAX	
V _{IK}		V _{CC} = 2.7 V, I _I = −18 mA		−1.2			−1.2			V
V _{OH}		V _{CC} = 2.7 V to 3.6 V, I _{OH} = −100 μA		V _{CC} − 0.2			V _{CC} − 0.2			V
		V _{CC} = 2.7 V, I _{OH} = −8 mA		2.4			2.4			
		V _{CC} = 3 V	I _{OH} = −24 mA	2						
			I _{OH} = −32 mA				2			
V _{OL}		V _{CC} = 2.7 V	I _{OL} = 100 μA	0.2			0.2			V
			I _{OL} = 24 mA	0.5			0.5			
		V _{CC} = 3 V	I _{OL} = 16 mA	0.4			0.4			
			I _{OL} = 32 mA	0.5			0.5			
			I _{OL} = 48 mA	0.55						
			I _{OL} = 64 mA				0.55			
I _I		V _{CC} = 0 or 3.6 V, V _I = 5.5 V		10			10			μA
	Control inputs	V _{CC} = 3.6 V, V _I = V _{CC} or GND		±1			±1			
	Data inputs	V _{CC} = 3.6 V	V _I = V _{CC}	1			1			
			V _I = 0	−5			−5			
I _{off}		V _{CC} = 0, V _I or V _O = 0 to 4.5 V					±100			μA
I _{I(hold)}	Data inputs	V _{CC} = 3 V	V _I = 0.8 V	75			75			μA
			V _I = 2 V	−75			−75			
		V _{CC} = 3.6 V, ⁽²⁾ V _I = 0 to 3.6 V					500 −750			
I _{OZH}		V _{CC} = 3.6 V, V _O = 3 V		5			5			μA
I _{OZL}		V _{CC} = 3.6 V, V _O = 0.5 V		−5			−5			μA
I _{OZPU}		V _{CC} = 0 to 1.5 V, V _O = 0.5 V to 3 V, $\overline{OE}$ = don't care		±100 ⁽³⁾			±100			μA
I _{OZPD}		V _{CC} = 1.5 V to 0, V _O = 0.5 V to 3 V, $\overline{OE}$ = don't care		±100 ⁽³⁾			±100			μA
I _{CC}		V _{CC} = 3.6 V, I _O = 0, V _I = V _{CC} or GND	Outputs high	0.19			0.19			mA
			Outputs low	5			5			
			Outputs disabled	0.19			0.19			
ΔI _{CC} ⁽⁴⁾		V _{CC} = 3 V to 3.6 V, One input at V _{CC} − 0.6 V, Other inputs at V _{CC} or GND		0.2			0.2			mA
C _I		V _I = 3 V or 0		4			4			pF
C _O		V _O = 3 V or 0		9			9			pF

(1) All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

(3) On products compliant to MIL-PRF-38535, this parameter is not production tested.

(4) This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.

SN54LVTH16541, SN74LVTH16541

3.3-V ABT 16-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

SCBS691E – MAY 1997 – REVISED NOVEMBER 2006

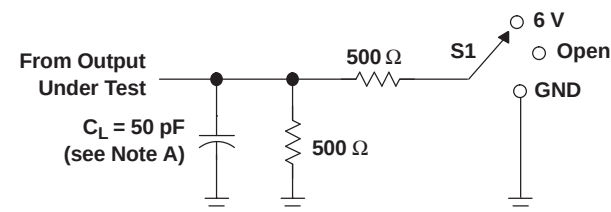
Switching Characteristics

over recommended operating free-air temperature range, $C_L = 50$ pF (unless otherwise noted) (see [Figure 1](#))

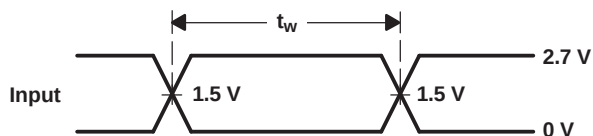
PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH16541				SN74LVTH16541				UNIT	
			V _{CC} = 3.3 V ± 0.3 V		V _{CC} = 2.7 V		V _{CC} = 3.3 V ± 0.3 V			V _{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	TYP ⁽¹⁾	MAX	MIN		MAX
t _{PLH}	A	Y	1	3.7		4	1	2.4	3.5		3.8	ns
t _{PHL}			1	3.7		4	1	2	3.5		3.8	
t _{PZH}	$\overline{OE}$	Y	1.1	4.8		5.7	1.2	2.7	4.6		5.5	ns
t _{PZL}			1.1	4.8		5.4	1.2	2.8	4.6		5.2	
t _{PHZ}	$\overline{OE}$	Y	2.1	6.2		6.5	2.2	4.1	5.9		6.2	ns
t _{PLZ}			1.9	5.7		6	2.2	3.8	5.4		5.5	
t _{sk(LH)}									0.5		0.5	ns
t _{sk(HL)}									0.5		0.5	

(1) All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

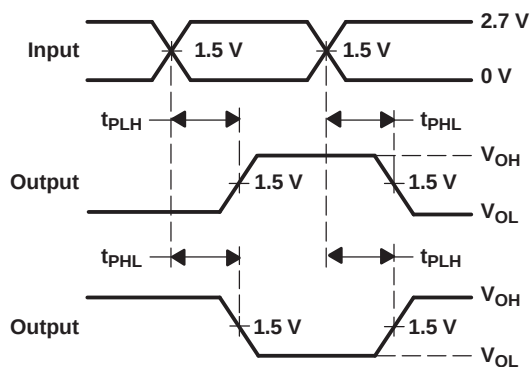
PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

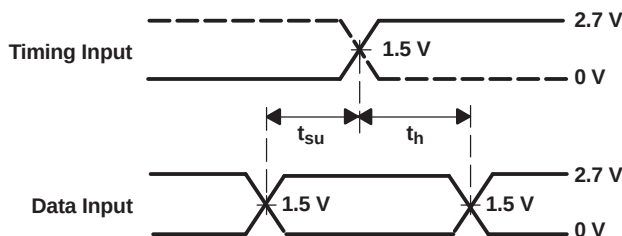


VOLTAGE WAVEFORMS
PULSE DURATION

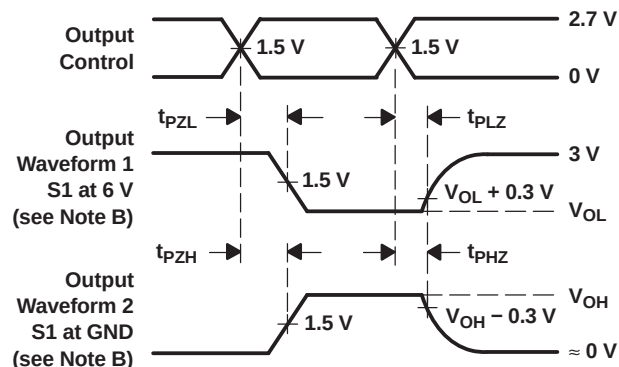


VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS

TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- 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 $\leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
D. The outputs are measured one at a time, with one transition per measurement.

Figure 1. 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)
SN74LVTH16541DGGR	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH16541
SN74LVTH16541DGGR.B	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH16541
SN74LVTH16541DL	Active	Production	SSOP (DL) 48	25 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH16541
SN74LVTH16541DL.B	Active	Production	SSOP (DL) 48	25 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH16541

⁽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.

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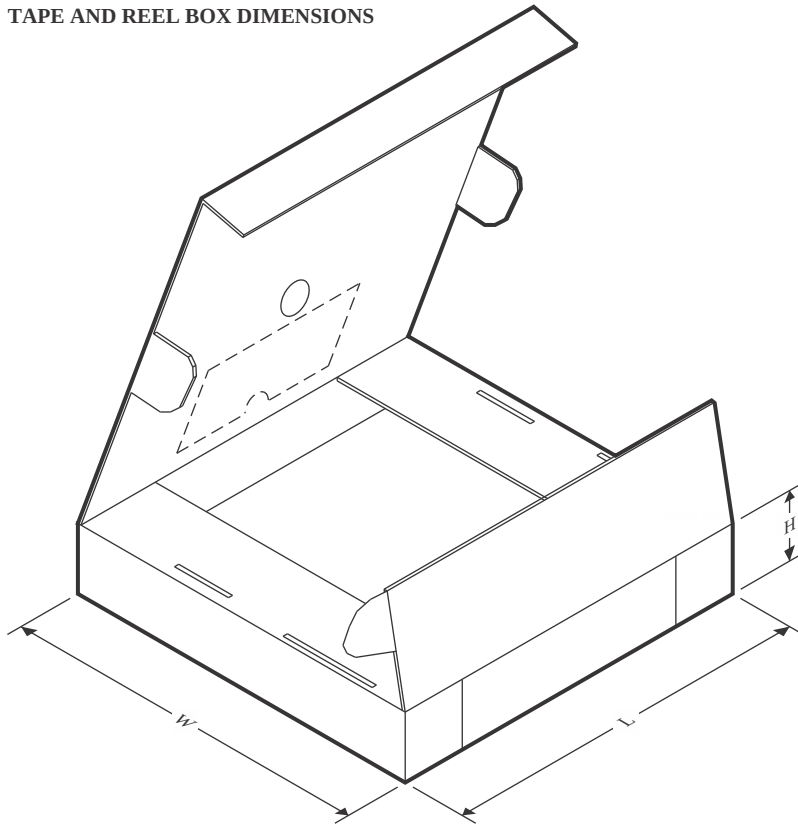
TAPE AND REEL INFORMATION



*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
SN74LVTH16541DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	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)
SN74LVTH16541DGGR	TSSOP	DGG	48	2000	356.0	356.0	45.0

TUBE

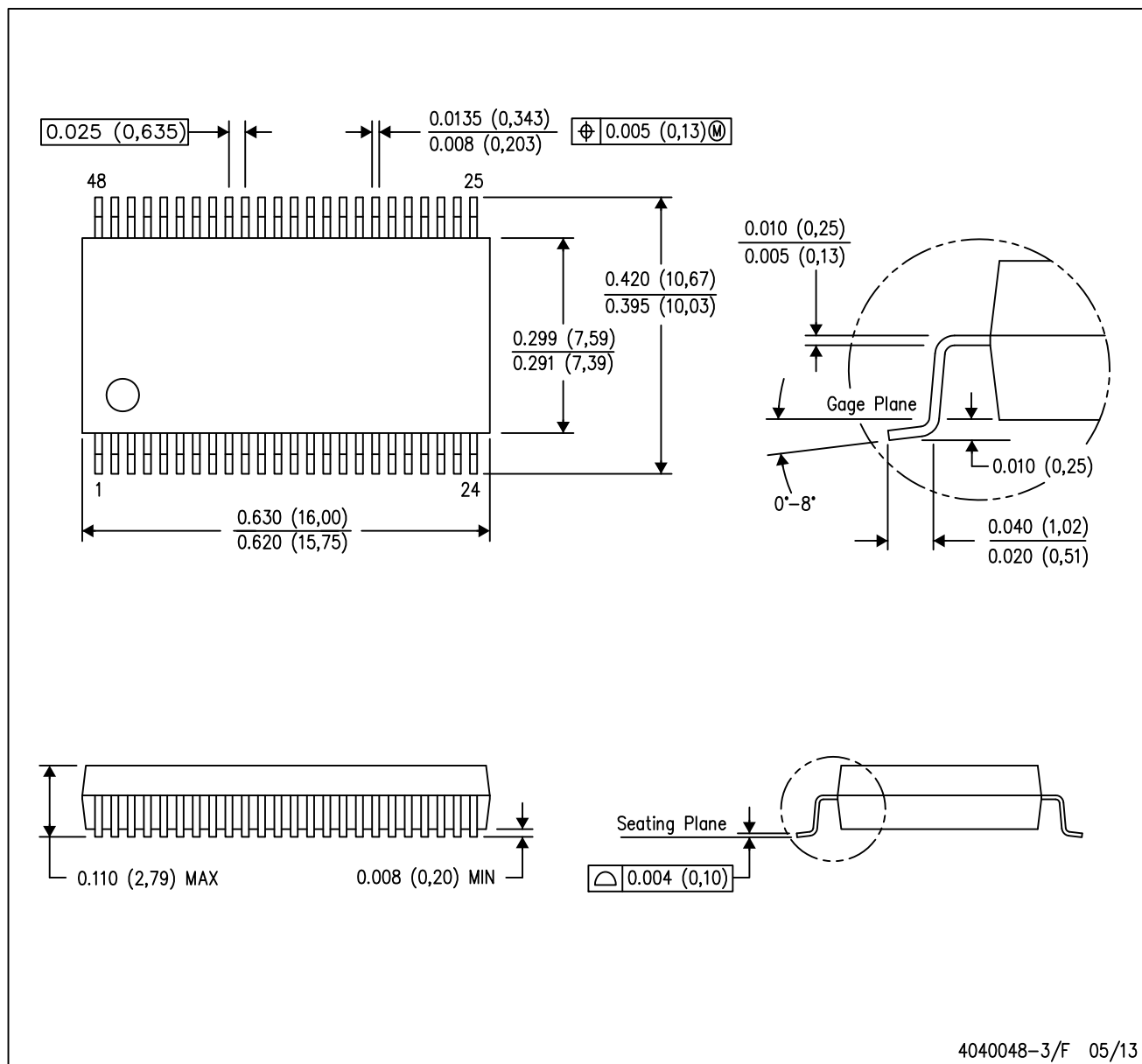


*All dimensions are nominal

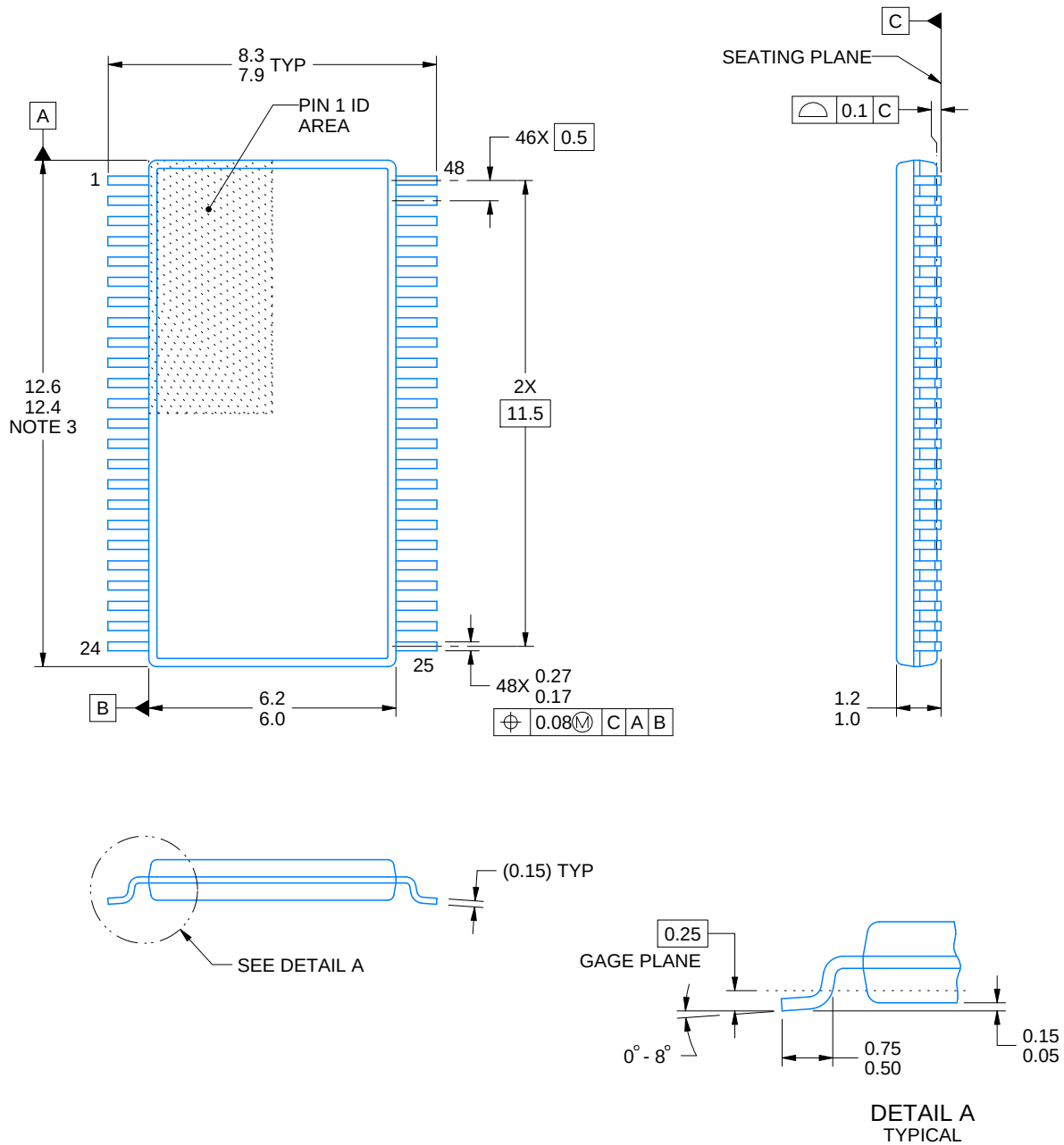
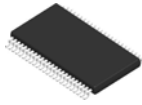
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74LVTH16541DL	DL	SSOP	48	25	473.7	14.24	5110	7.87
SN74LVTH16541DL.B	DL	SSOP	48	25	473.7	14.24	5110	7.87

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MO-118



4214859/B 11/2020

NOTES:

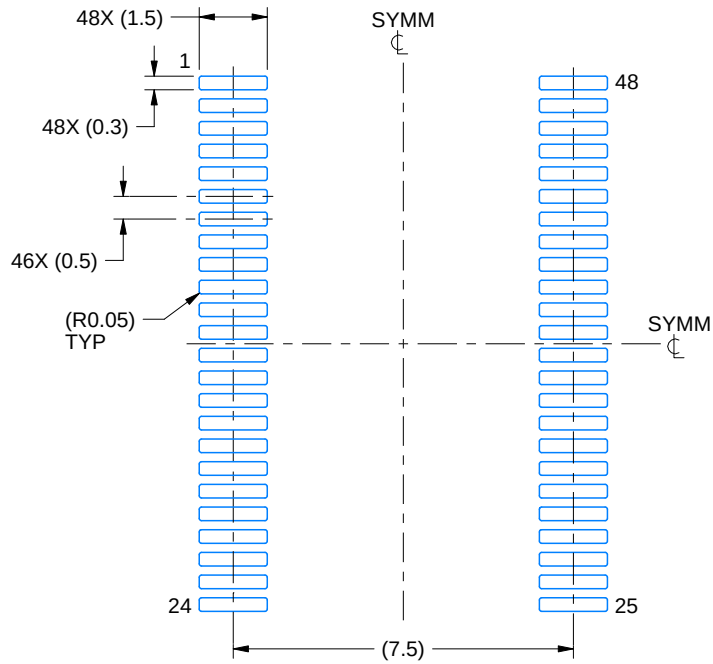
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

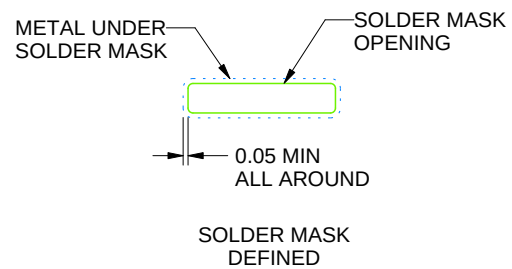
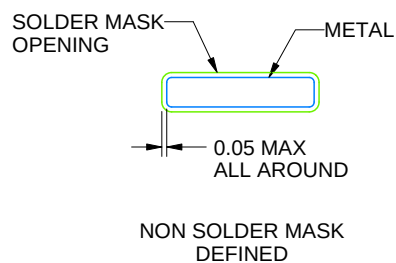
DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

4214859/B 11/2020

NOTES: (continued)

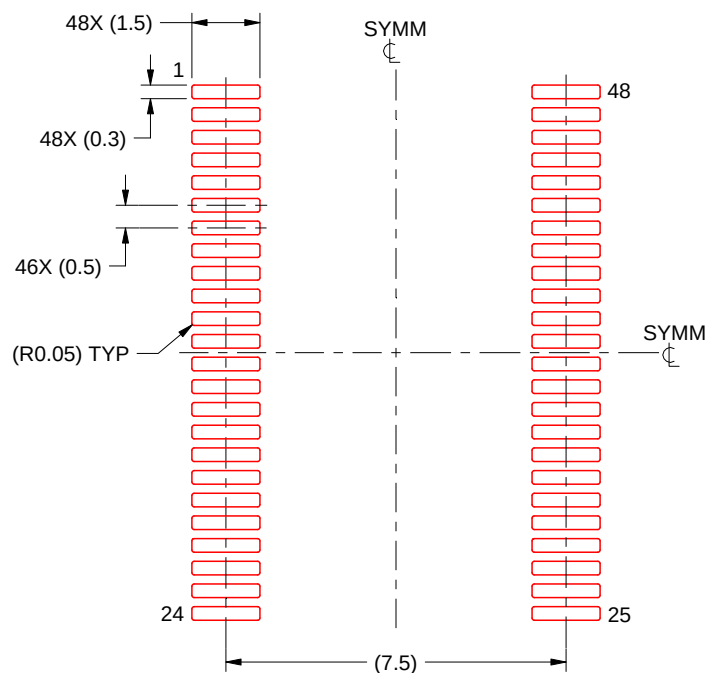
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4214859/B 11/2020

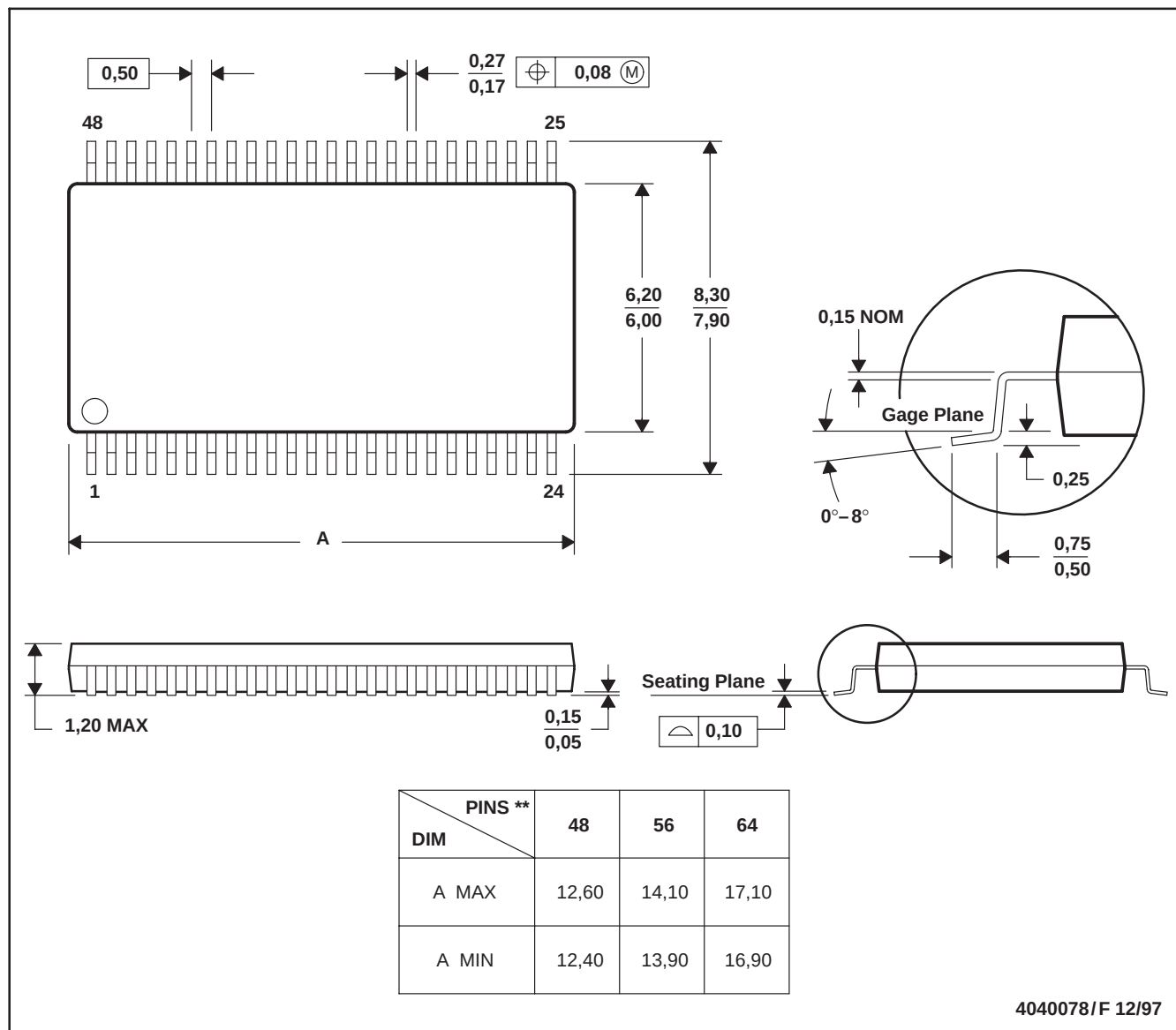
NOTES: (continued)

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

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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