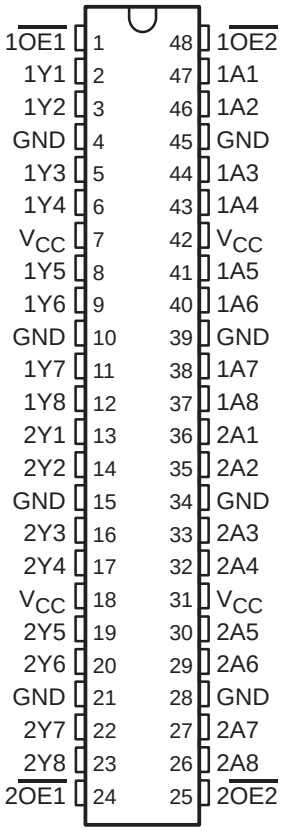
- **Members of the Texas Instruments *Widebus*™ Family**
- ***EPIC*™ (Enhanced-Performance Implanted CMOS) Process**
- **Operating Range 2-V to 5.5-V $V_{CC}$**
- **Distributed $V_{CC}$ and GND Pins Minimize High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **Package Options Include Plastic Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG), and Thin Very Small-Outline (DGV) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

**SN54AHC16541 . . . WD PACKAGE**
**SN74AHC16541 . . . DGG, DGV, OR DL PACKAGE**
**(TOP VIEW)**




## description

The ’AHC16541 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 (1$\overline{OE1}$ and 1$\overline{OE2}$ or 2$\overline{OE1}$ and 2$\overline{OE2}$) 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.

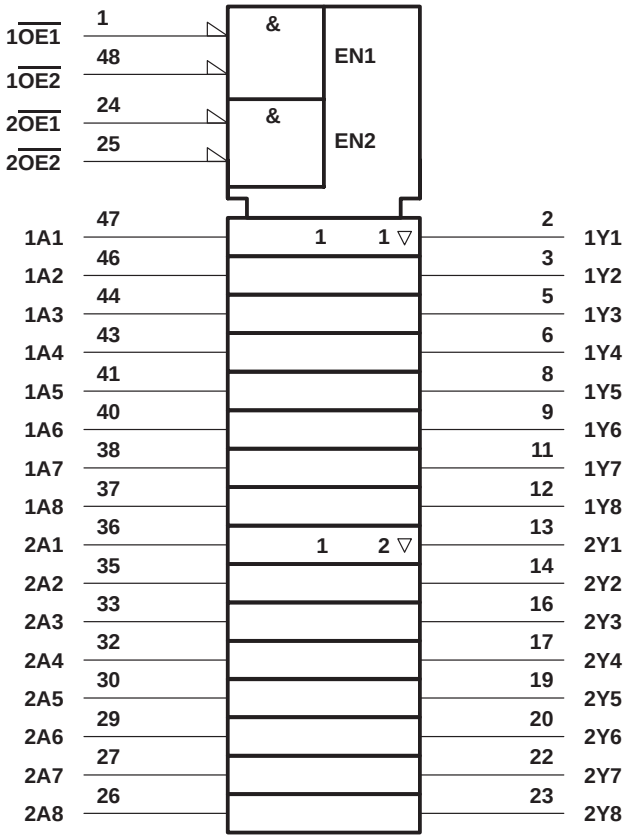
To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to $V_{CC}$ through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

The SN54AHC16541 is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74AHC16541 is characterized for operation from –40°C to 85°C.

**FUNCTION TABLE**
**(each 8-bit buffer/driver)**

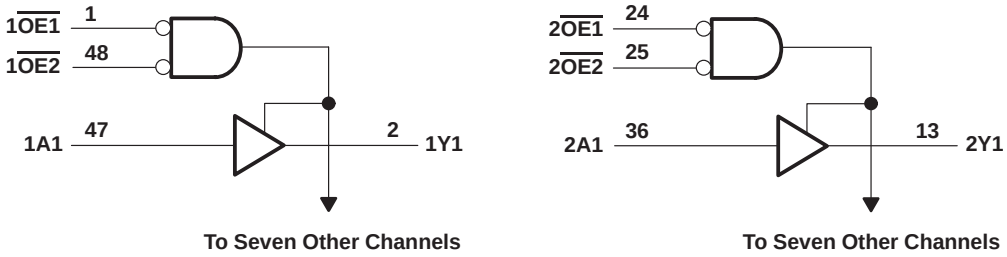
| INPUTS | | | OUTPUT |
|---|---|---|---|
| $\overline{OE1}$ | $\overline{OE2}$ | A | Y |
| L | L | L | L |
| L | L | H | H |
| H | X | X | Z |
| X | H | X | Z |

## logic symbol†




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

## 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
Output voltage range, $V_O$ (see Note 1) . . . . . –0.5 V to $V_{CC}$ + 0.5 V
Input clamp current, $I_{IK}$ ($V_I$ < 0) . . . . . –20 mA
Output clamp current, $I_{OK}$ ($V_O$ < 0 or $V_O$ > $V_{CC}$) . . . . . ±20 mA
Continuous output current, $I_O$ ($V_O$ = 0 to $V_{CC}$) . . . . . ±25 mA
Continuous current through each $V_{CC}$ or GND . . . . . ±75 mA
Package thermal impedance, $\theta_{JA}$ (see Note 2): DGG package . . . . . 70°C/W
DGV package . . . . . 58°C/W
DL package . . . . . 63°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.

### recommended operating conditions (see Note 3)

| | | | SN54AHC16541 | | SN74AHC16541 | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| $V_{CC}$ | Supply voltage | | 2 | 5.5 | 2 | 5.5 | V |
| $V_{IH}$ | High-level input voltage | $V_{CC}$ = 2 V | 1.5 | | 1.5 | | V |
| | | $V_{CC}$ = 3 V | 2.1 | | 2.1 | | |
| | | $V_{CC}$ = 5.5 V | 3.85 | | 3.85 | | |
| $V_{IL}$ | Low-level input voltage | $V_{CC}$ = 2 V | | 0.5 | | 0.5 | V |
| | | $V_{CC}$ = 3 V | | 0.9 | | 0.9 | |
| | | $V_{CC}$ = 5.5 V | | 1.65 | | 1.65 | |
| $V_I$ | Input voltage | | 0 | 5.5 | 0 | 5.5 | V |
| $V_O$ | Output voltage | | 0 | $V_{CC}$ | 0 | $V_{CC}$ | V |
| $I_{OH}$ | High-level output current | $V_{CC}$ = 2 V | | –50 | | –50 | μA |
| | | $V_{CC}$ = 3.3 V ± 0.3 V | | –4 | | –4 | mA |
| | | $V_{CC}$ = 5 V ± 0.5 V | | –8 | | –8 | |
| $I_{OL}$ | Low-level output current | $V_{CC}$ = 2 V | | 50 | | 50 | μA |
| | | $V_{CC}$ = 3.3 V ± 0.3 V | | 4 | | 4 | mA |
| | | $V_{CC}$ = 5 V ± 0.5 V | | 8 | | 8 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | $V_{CC}$ = 3.3 V ± 0.3 V | | 100 | | 100 | ns/V |
| | | $V_{CC}$ = 5 V ± 0.5 V | | 20 | | 20 | |
| $T_A$ | Operating free-air temperature | | –55 | 125 | –40 | 85 | °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 | $V_{CC}$ | $T_A$ = 25°C | | | SN54AHC16541 | | SN74AHC16541 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $V_{OH}$ | $I_{OH}$ = –50 μA | 2 V | 1.9 | 2 | | 1.9 | | 1.9 | | V |
| | | 3 V | 2.9 | 3 | | 2.9 | | 2.9 | | |
| | | 4.5 V | 4.4 | 4.5 | | 4.4 | | 4.4 | | |
| | $I_{OH}$ = –4 mA | 3 V | 2.58 | | | 2.48 | | 2.48 | | |
| | $I_{OH}$ = –8 mA | 4.5 V | 3.94 | | | 3.8 | | 3.8 | | |
| $V_{OL}$ | $I_{OL}$ = 50 μA | 2 V | | | 0.1 | | 0.1 | | 0.1 | V |
| | | 3 V | | | 0.1 | | 0.1 | | 0.1 | |
| | | 4.5 V | | | 0.1 | | 0.1 | | 0.1 | |
| | $I_{OL}$ = 4 mA | 3 V | | | 0.36 | | 0.5 | | 0.44 | |
| | $I_{OL}$ = 8 mA | 4.5 V | | | 0.36 | | 0.5 | | 0.44 | |
| $I_I$ | $V_I = V_{CC}$ or GND | 0 V to 5.5 V | | | ±0.1 | | ±1* | | ±1 | μA |
| $I_{OZ}$ | $V_O = V_{CC}$ or GND, $V_I$ ($\overline{OE}$) = $V_{IL}$ or $V_{IH}$ | 5.5 V | | | ±0.25 | | ±2.5 | | ±2.5 | μA |
| $I_{CC}$ | $V_I = V_{CC}$ or GND, $I_O$ = 0 | 5.5 V | | | 4 | | 40 | | 40 | μA |
| $C_i$ | $V_I = V_{CC}$ or GND | 5 V | | 2 | 10 | | | | 10 | pF |
| $C_o$ | $V_O = V_{CC}$ or GND | 5 V | | 3 | | | | | | pF |

* On products compliant to MIL-PRF-38535, this parameter is not production tested at $V_{CC}$ = 0 V.

## switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | $T_A$ = 25°C | | | SN54AHC16541 | | SN74AHC16541 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ | A | Y | $C_L$ = 15 pF | | 5** | 8.4** | 1** | 10** | 1 | 10 | ns |
| $t_{PHL}$ | | | | | 5** | 8.4** | 1** | 10** | 1 | 10 | |
| $t_{PZH}$ | $\overline{OE}$ | Y | $C_L$ = 15 pF | | 6** | 10.6** | 1** | 12.5** | 1 | 12.5 | ns |
| $t_{PZL}$ | | | | | 6** | 10.6** | 1** | 12.5** | 1 | 12.5 | |
| $t_{PHZ}$ | $\overline{OE}$ | Y | $C_L$ = 15 pF | | 7** | 11.5** | 1** | 12.5** | 1 | 12.5 | ns |
| $t_{PLZ}$ | | | | | 7** | 11.5** | 1** | 12.5** | 1 | 12.5 | |
| $t_{PLH}$ | A | Y | $C_L$ = 50 pF | | 7.5 | 11.9 | 1 | 13.5 | 1 | 13.5 | ns |
| $t_{PHL}$ | | | | | 7.5 | 11.9 | 1 | 13.5 | 1 | 13.5 | |
| $t_{PZH}$ | $\overline{OE}$ | Y | $C_L$ = 50 pF | | 8 | 14.1 | 1 | 16 | 1 | 16 | ns |
| $t_{PZL}$ | | | | | 8 | 14.1 | 1 | 16 | 1 | 16 | |
| $t_{PHZ}$ | $\overline{OE}$ | Y | $C_L$ = 50 pF | | 9 | 14 | 1 | 16 | 1 | 16 | ns |
| $t_{PLZ}$ | | | | | 9 | 14 | 1 | 16 | 1 | 16 | |
| $t_{sk(o)}$ | | | $C_L$ = 50 pF | | | 1.5*** | | | | 1.5 | ns |

** On products compliant to MIL-PRF-38535, this parameter is not production tested.
*** On products compliant to MIL-PRF-38535, this parameter does not apply.

## switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | $T_A$ = 25°C | | | SN54AHC16541 | | SN74AHC16541 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ | A | Y | $C_L$ = 15 pF | | 3.5* | 6* | 1* | 7* | 1 | 6.5 | ns |
| $t_{PHL}$ | | | | | 3.5* | 6* | 1* | 7* | 1 | 6.5 | |
| $t_{PZH}$ | $\overline{OE}$ | Y | $C_L$ = 15 pF | | 4.7* | 7.3* | 1* | 8.5* | 1 | 8.5 | ns |
| $t_{PZL}$ | | | | | 4.7* | 7.3* | 1* | 8.5* | 1 | 8.5 | |
| $t_{PHZ}$ | $\overline{OE}$ | Y | $C_L$ = 15 pF | | 5* | 7.2* | 1* | 8.5* | 1 | 8.5 | ns |
| $t_{PLZ}$ | | | | | 5* | 7.2* | 1* | 8.5* | 1 | 8.5 | |
| $t_{PLH}$ | A | Y | $C_L$ = 50 pF | | 5 | 8 | 1 | 9 | 1 | 8.5 | ns |
| $t_{PHL}$ | | | | | 5 | 8 | 1 | 9 | 1 | 8.5 | |
| $t_{PZH}$ | $\overline{OE}$ | Y | $C_L$ = 50 pF | | 6.2 | 9.3 | 1 | 10.5 | 1 | 10.5 | ns |
| $t_{PZL}$ | | | | | 6.2 | 9.3 | 1 | 10.5 | 1 | 10.5 | |
| $t_{PHZ}$ | $\overline{OE}$ | Y | $C_L$ = 50 pF | | 6 | 9.2 | 1 | 10.5 | 1 | 10.5 | ns |
| $t_{PLZ}$ | | | | | 6 | 9.2 | 1 | 10.5 | 1 | 10.5 | |
| $t_{sk(o)}$ | | | $C_L$ = 50 pF | | | 1** | | | | 1 | ns |



* On products compliant to MIL-PRF-38535, this parameter is not production tested.
** On products compliant to MIL-PRF-38535, this parameter does not apply.

## noise characteristics, $V_{CC}$ = 5 V, $C_L$ = 50 pF, $T_A$ = 25°C (see Note 4)

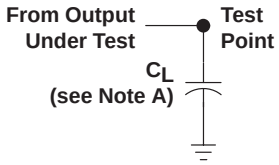
| PARAMETER | | SN74AHC16541 | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP | MAX | |
| $V_{OL(P)}$ | Quiet output, maximum dynamic $V_{OL}$ | | 0.7 | | V |
| $V_{OL(V)}$ | Quiet output, minimum dynamic $V_{OL}$ | | –0.3 | | V |
| $V_{OH(V)}$ | Quiet output, minimum dynamic $V_{OH}$ | | 4.7 | | V |
| $V_{IH(D)}$ | High-level dynamic input voltage | 3.5 | | | V |
| $V_{IL(D)}$ | Low-level dynamic input voltage | | | 1.5 | V |

NOTE 4: Characteristics are for surface-mount packages only.

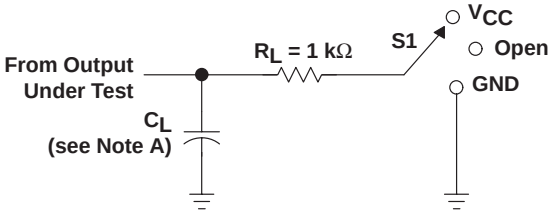
## operating characteristics, $V_{CC}$ = 5 V, $T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | | TYP | UNIT |
|---|---|---|---|---|---|
| $C_{pd}$ | Power dissipation capacitance | No load, | f = 1 MHz | 12 | pF |

## PARAMETER MEASUREMENT INFORMATION

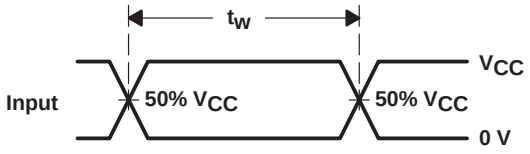



LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

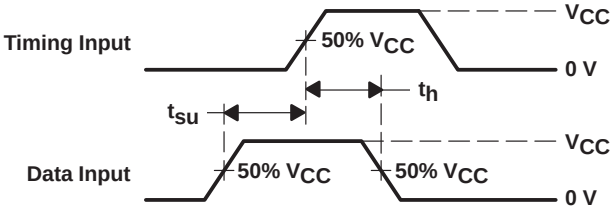



LOAD CIRCUIT FOR
3-STATE AND OPEN-DRAIN OUTPUTS

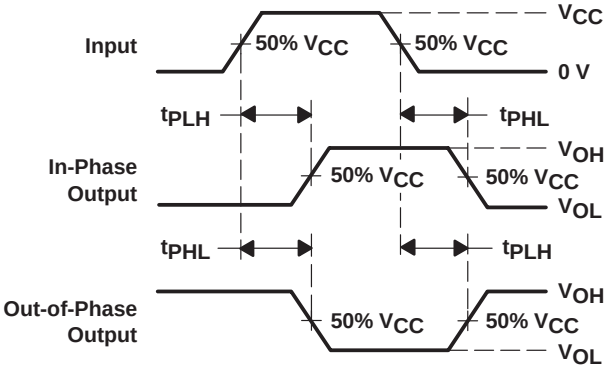
| TEST | S1 |
|---|---|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | $V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND |
| Open Drain | $V_{CC}$ |



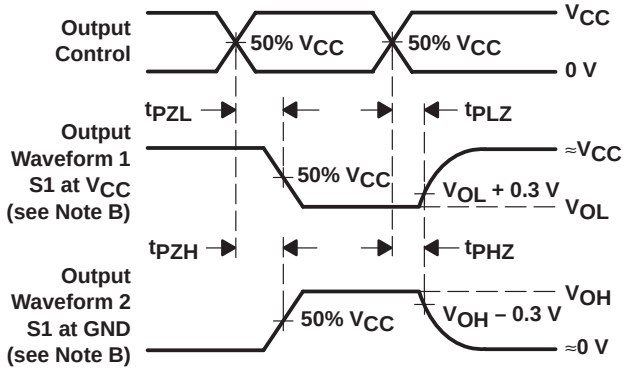

VOLTAGE WAVEFORMS
PULSE DURATION




VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES




VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS




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 ≤ 1 MHz, $Z_O$ = 50 Ω, $t_r$ ≤ 3 ns, $t_f$ ≤ 3 ns.
D. The outputs are measured one at a time with one input transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SN74AHC16541DGGR | ACTIVE | TSSOP | DGG | 48 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AHC16541 | Samples |
| SN74AHC16541DGVR | ACTIVE | TVSOP | DGV | 48 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | HE541 | Samples |
| SN74AHC16541DL | ACTIVE | SSOP | DL | 48 | 25 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AHC16541 | Samples |
| SN74AHC16541DLR | ACTIVE | SSOP | DL | 48 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AHC16541 | 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.
**OBSOLETE:** 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.

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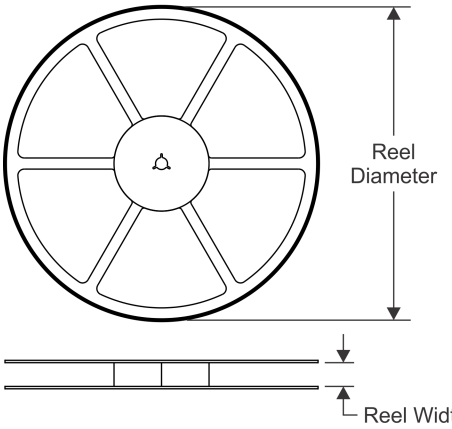
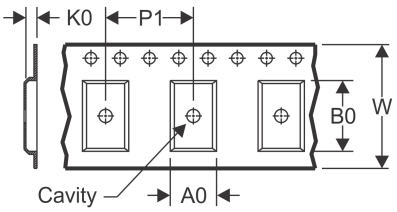
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

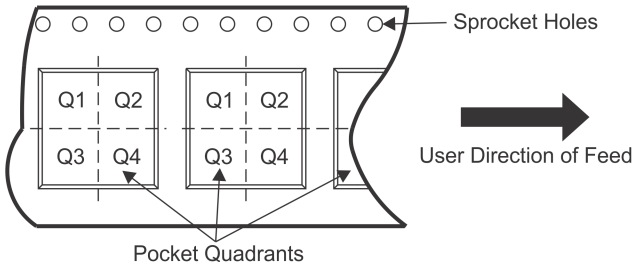



**TAPE DIMENSIONS**




| | |
|---|---|
| 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 |

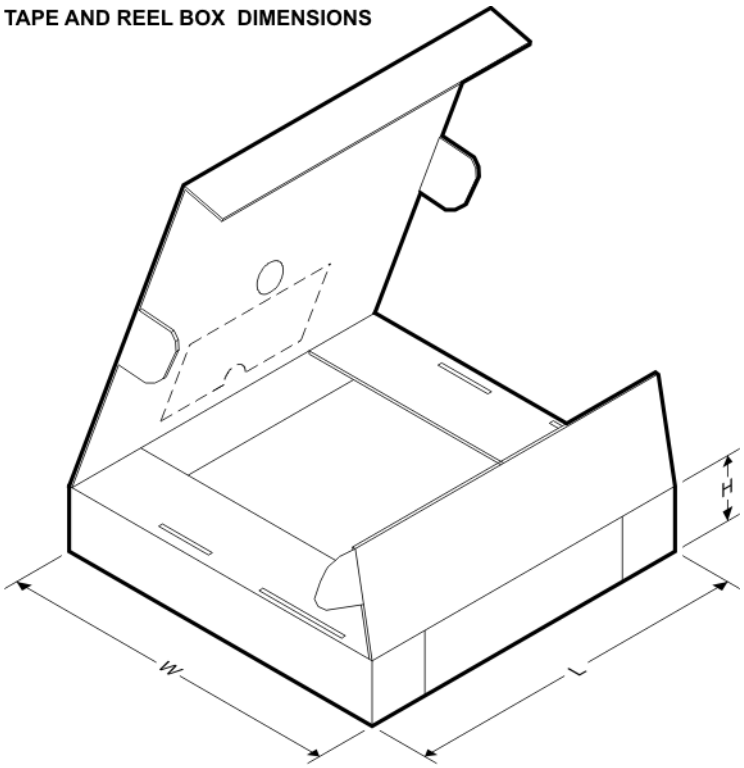
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SN74AHC16541DGGR | TSSOP | DGG | 48 | 2000 | 330.0 | 24.4 | 8.6 | 13.0 | 1.8 | 12.0 | 24.0 | Q1 |
| SN74AHC16541DGVR | TVSOP | DGV | 48 | 2000 | 330.0 | 16.4 | 7.1 | 10.2 | 1.6 | 12.0 | 16.0 | Q1 |
| SN74AHC16541DLR | SSOP | DL | 48 | 1000 | 330.0 | 32.4 | 11.35 | 16.2 | 3.1 | 16.0 | 32.0 | Q1 |

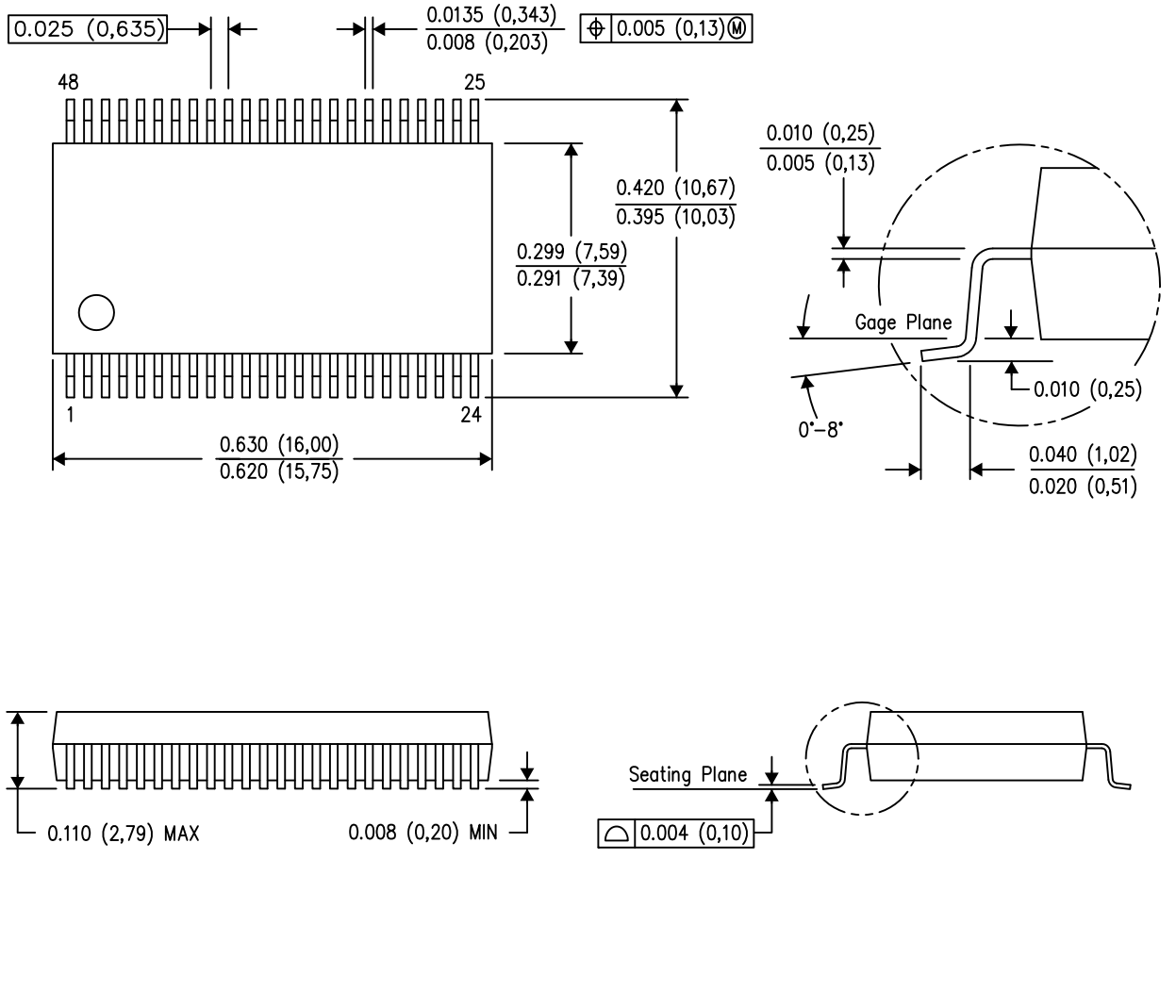
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| SN74AHC16541DGGR | TSSOP | DGG | 48 | 2000 | 367.0 | 367.0 | 45.0 |
| SN74AHC16541DGVR | TVSOP | DGV | 48 | 2000 | 853.0 | 449.0 | 35.0 |
| SN74AHC16541DLR | SSOP | DL | 48 | 1000 | 367.0 | 367.0 | 55.0 |

DL (R–PDSO–G48) PLASTIC SMALL–OUTLINE PACKAGE

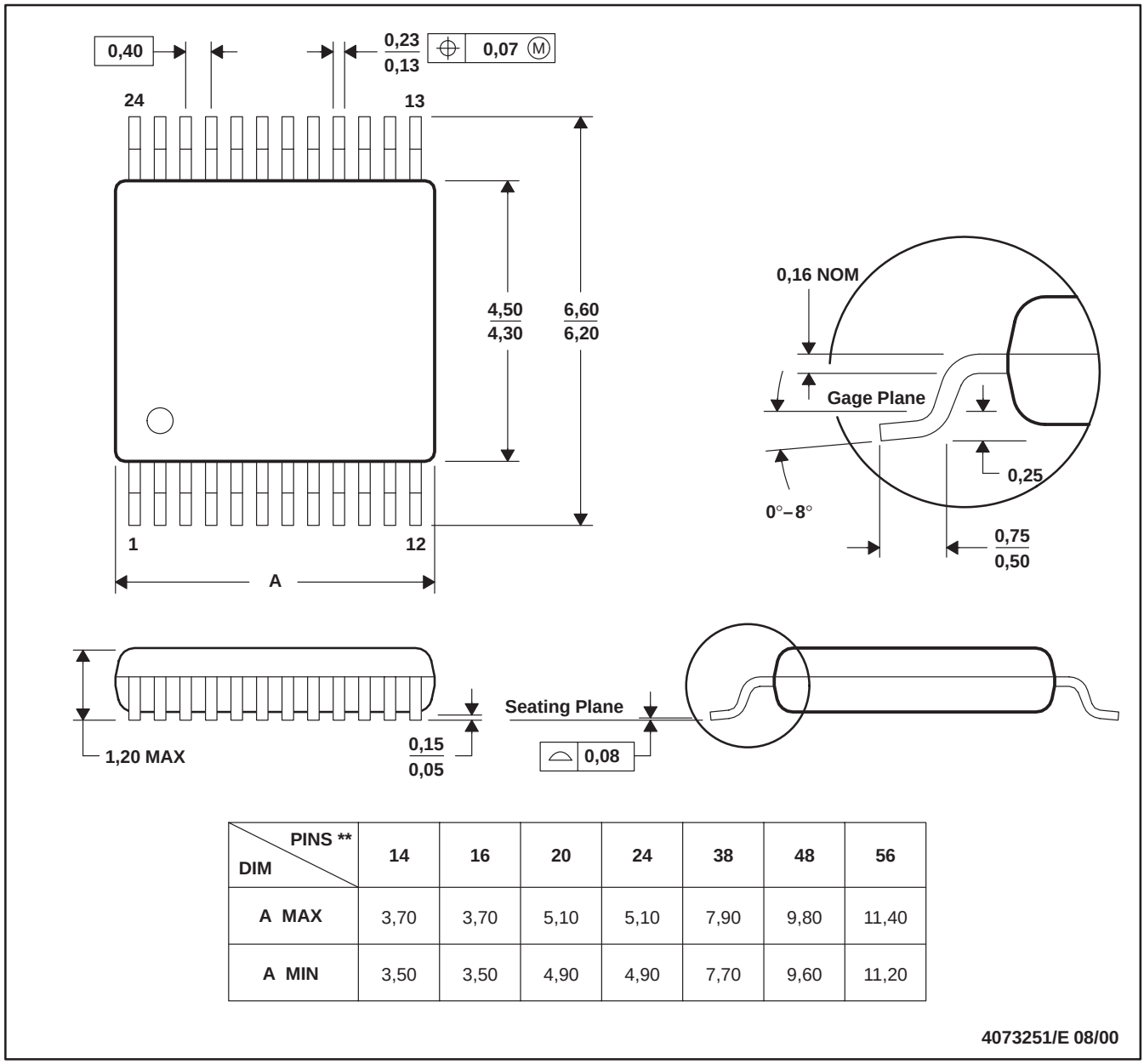



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MO–118

PowerPAD is a trademark of Texas Instruments.

**DGV (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE**

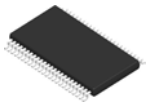
**24 PINS SHOWN**




| DIM \ PINS ** | 14 | 16 | 20 | 24 | 38 | 48 | 56 |
|---|---|---|---|---|---|---|---|
| A MAX | 3,70 | 3,70 | 5,10 | 5,10 | 7,90 | 9,80 | 11,40 |
| A MIN | 3,50 | 3,50 | 4,90 | 4,90 | 7,70 | 9,60 | 11,20 |

**4073251/E 08/00**

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 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

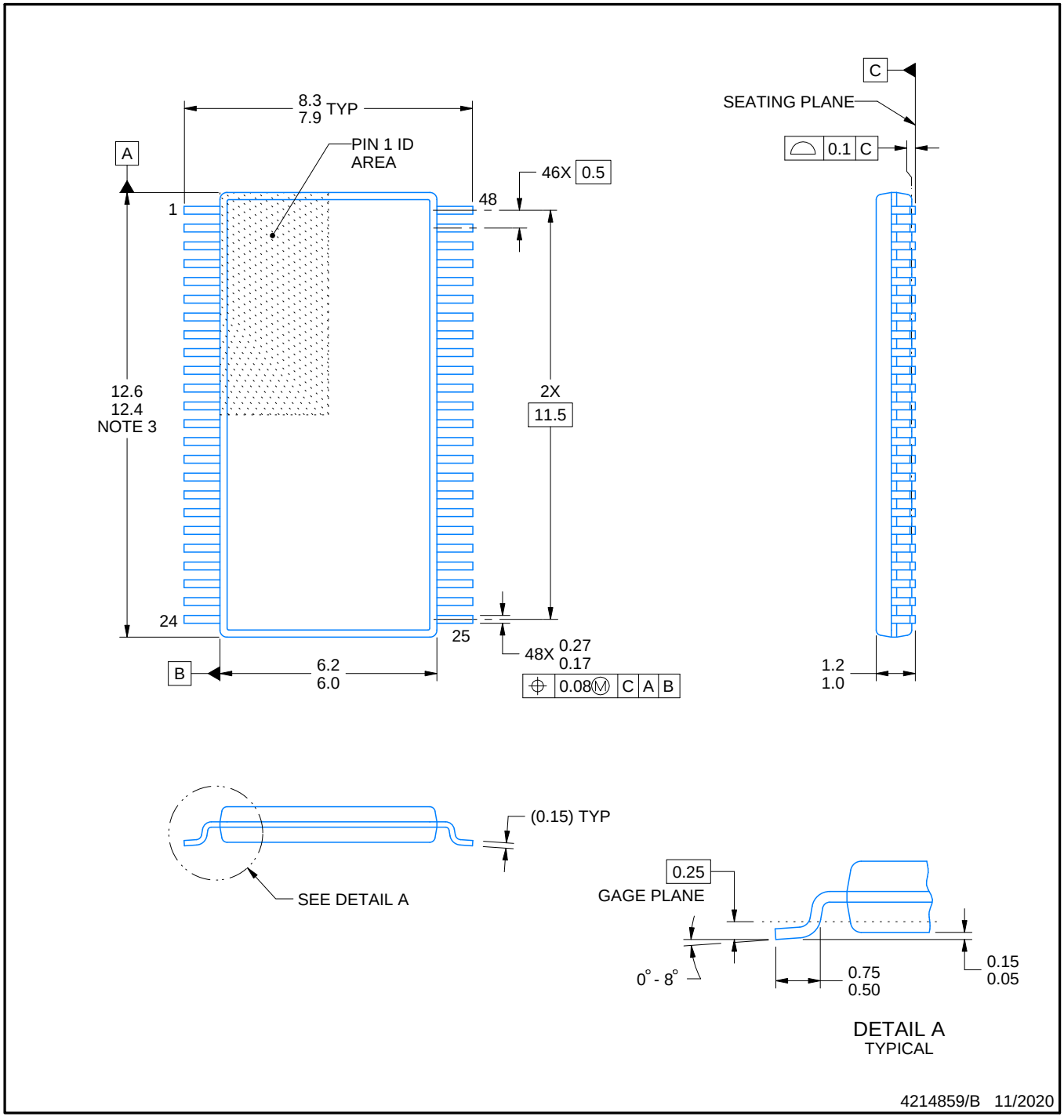


# PACKAGE OUTLINE

## DGG0048A

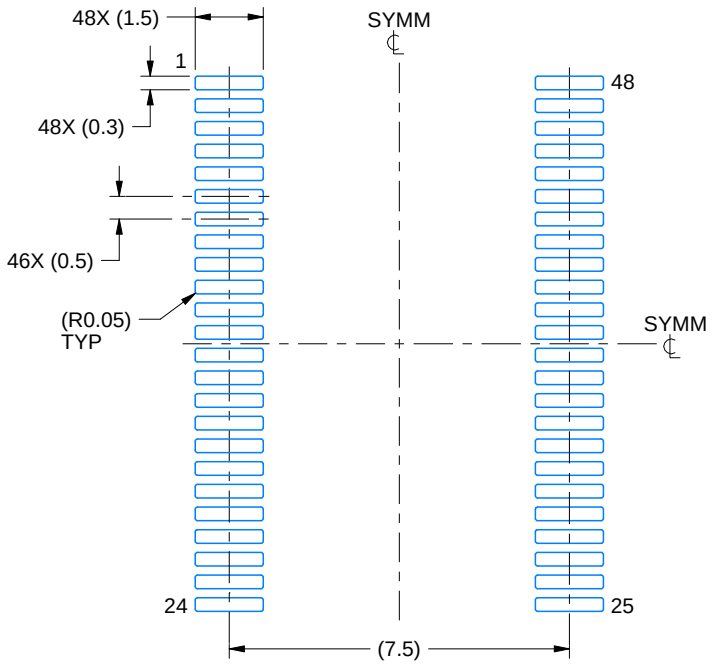
## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

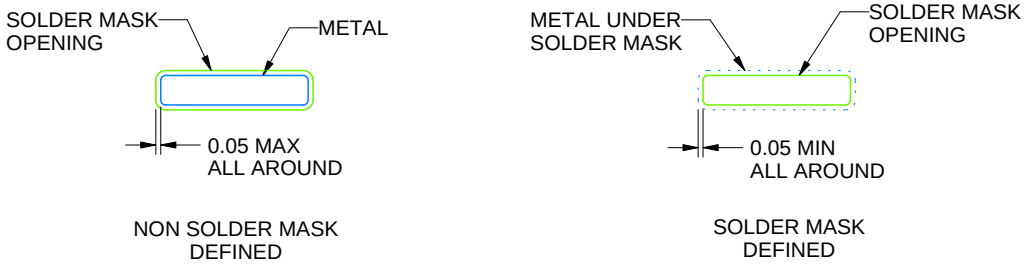



NOTES:

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. Reference JEDEC registration MO-153.




LAND PATTERN EXAMPLE
SCALE:6X

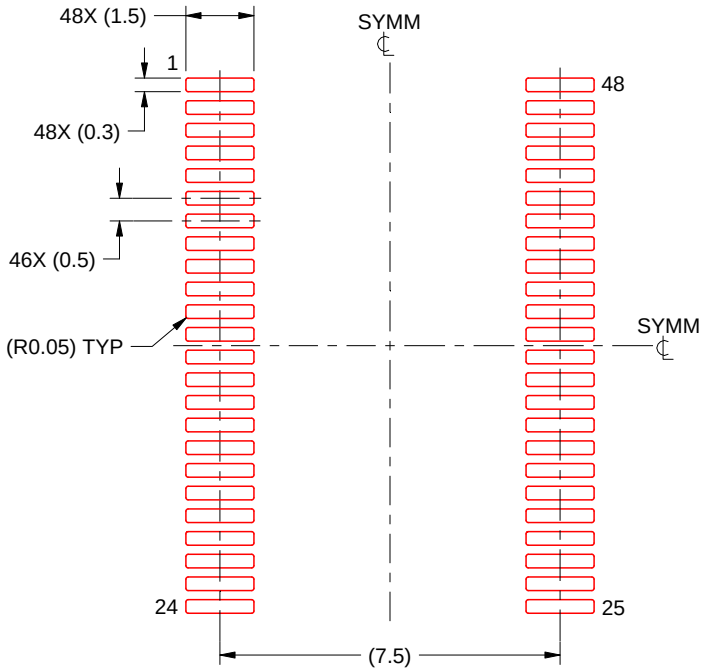



SOLDER MASK DETAILS

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.




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

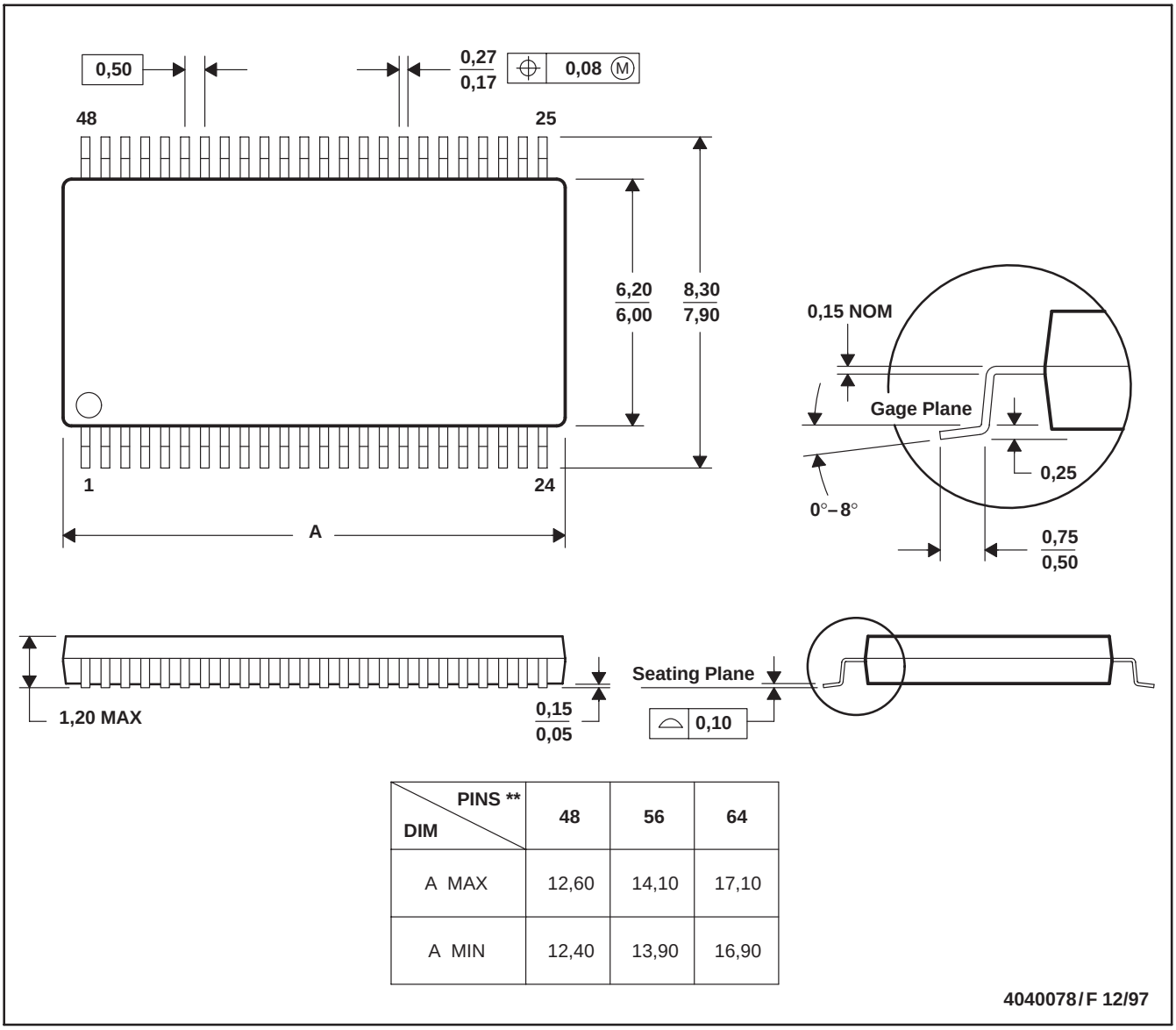
4214859/B 11/2020

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**




| DIM \ PINS ** | 48 | 56 | 64 |
|---|---|---|---|
| A MAX | 12,60 | 14,10 | 17,10 |
| A MIN | 12,40 | 13,90 | 16,90 |

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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