

# SN74CBT16244C

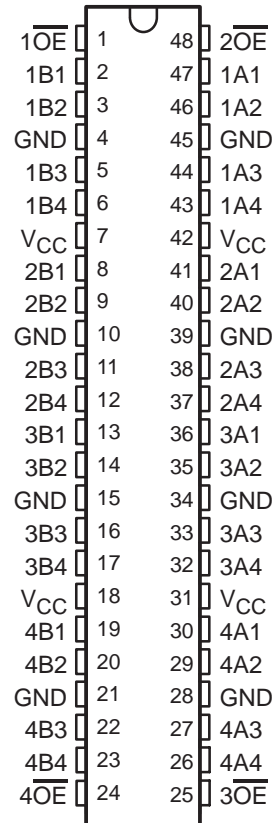
## 16-BIT FET BUS SWITCH

### 5-V BUS SWITCH WITH $-2$ -V UNDERSHOOT PROTECTION

SCDS134A – SEPTEMBER 2003 – REVISED OCTOBER 2003

- Member of the Texas Instruments Widebus™ Family
- Undershoot Protection for Off-Isolation on A and B Ports Up To  $-2$  V
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low ON-State Resistance ( $r_{on}$ ) Characteristics ( $r_{on} = 3 \Omega$  Typical)
- Low Input/Output Capacitance Minimizes Loading and Signal Distortion ( $C_{iO(OFF)} = 5.5$  pF Typical)
- Data and Control Inputs Provide Undershoot Clamp Diodes
- Low Power Consumption ( $I_{CC} = 3 \mu A$  Max)
- $V_{CC}$  Operating Range From 4 V to 5.5 V
- Data I/Os Support 0 to 5-V Signaling Levels (0.8-V, 1.2-V, 1.5-V, 1.8-V, 2.5-V, 3.3-V, 5-V)
- Control Inputs Can Be Driven by TTL or 5-V/3.3-V CMOS Outputs
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
  - 2000-V Human-Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)
- Supports Both Digital and Analog Applications: PCI Interface, Memory Interleaving, Bus Isolation, Low-Distortion Signal Gating

DGG, DGV, OR DL PACKAGE  
(TOP VIEW)



#### description/ordering information

#### ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SSOP – DL	Tube	SN74CBT16244CDL	CBT16244C
		Tape and reel	SN74CBT16244CDLR	
	TSSOP – DGG	Tube	SN74CBT16244CDGG	CBT16244C
		Tape and reel	SN74CBT16244CDGGR	
TVSOP – DGV	Tape and reel	SN74CBT16244CDGVR	CY244C	

† 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).



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#### description/ordering information (continued)

The SN74CBT16244C is a high-speed TTL-compatible FET bus switch with low ON-state resistance ( $r_{on}$ ), allowing for minimal propagation delay. Active Undershoot-Protection Circuitry on the A and B ports of the SN74CBT16244C provides protection for undershoot up to  $-2$  V by sensing an undershoot event and ensuring that the switch remains in the proper OFF state.

The SN74CBT16244C is organized as four 4-bit bus switches with separate output-enable ( $1\overline{OE}$ ,  $2\overline{OE}$ ,  $3\overline{OE}$ ,  $4\overline{OE}$ ) inputs. It can be used as four 4-bit bus switches, two 8-bit bus switches, or as one 16-bit bus switch. When  $\overline{OE}$  is low, the associated 4-bit bus switch is ON, and the A port is connected to the B port, allowing bidirectional data flow between ports. When  $\overline{OE}$  is high, the associated 4-bit bus switch is OFF, and the high-impedance state exists between the A and B ports.

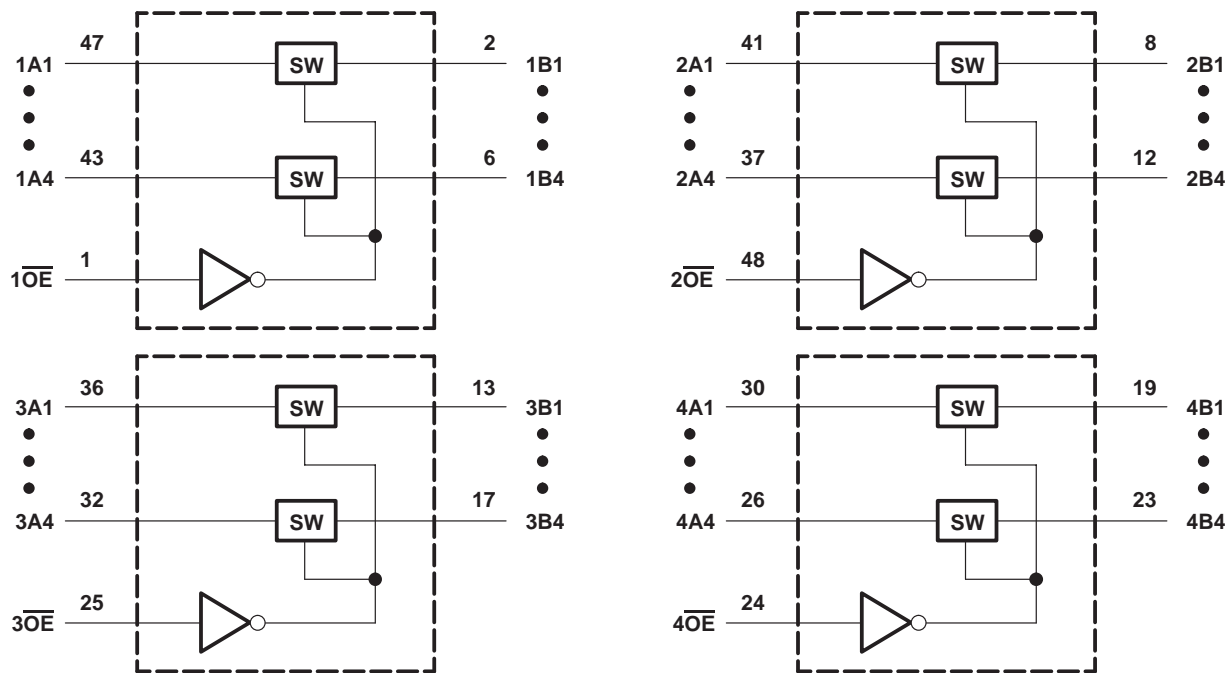
This device is fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  feature ensures that damaging current will not backflow through the device when it is powered down. The device has isolation during power off.

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 4-bit bus switch)

INPUT $\overline{OE}$	INPUT/OUTPUT A	FUNCTION
L	B	A port = B port
H	Z	Disconnect

#### logic diagram (positive logic)





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

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>	Control inputs	V <sub>CC</sub> = 4.5 V,	I <sub>IN</sub> = -18 mA			-1.8	V
V <sub>IKU</sub>	Data inputs	V <sub>CC</sub> = 5 V,	0 mA > I <sub>I</sub> ≥ -50 mA, V <sub>IN</sub> = V <sub>CC</sub> or GND, Switch OFF			-2	V
I <sub>IN</sub>	Control inputs	V <sub>CC</sub> = 5.5 V,	V <sub>IN</sub> = V <sub>CC</sub> or GND			±1	μA
I <sub>OZ</sub> ‡		V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 0 to 5.5 V, V <sub>I</sub> = 0, Switch OFF, V <sub>IN</sub> = V <sub>CC</sub> or GND			±10	μA
I <sub>off</sub>		V <sub>CC</sub> = 0,	V <sub>O</sub> = 0 to 5.5 V, V <sub>I</sub> = 0			10	μA
I <sub>CC</sub>		V <sub>CC</sub> = 5.5 V,	I <sub>I/O</sub> = 0, V <sub>IN</sub> = V <sub>CC</sub> or GND, Switch ON or OFF			3	μA
ΔI <sub>CC</sub> §	Control inputs	V <sub>CC</sub> = 5.5 V,	One input at 3.4 V, Other inputs at V <sub>CC</sub> or GND			2.5	mA
C <sub>in</sub>	Control inputs	V <sub>IN</sub> = 3 V or 0			3.5		pF
C <sub>io</sub> (OFF)		V <sub>I/O</sub> = 3 V or 0, Switch OFF, V <sub>IN</sub> = V <sub>CC</sub> or GND			5.5		pF
C <sub>io</sub> (ON)		V <sub>I/O</sub> = 3 V or 0, Switch ON, V <sub>IN</sub> = V <sub>CC</sub> or GND			14		pF
r <sub>on</sub> ¶	V <sub>CC</sub> = 4 V, TYP at V <sub>CC</sub> = 4 V	V <sub>I</sub> = 2.4 V,	I <sub>O</sub> = -15 mA	8	12	Ω	
			I <sub>O</sub> = 64 mA	3	6		
	V <sub>CC</sub> = 4.5 V	V <sub>I</sub> = 0	I <sub>O</sub> = 30 mA	3	6		
			V <sub>I</sub> = 2.4 V, I <sub>O</sub> = -15 mA	5	10		

V<sub>IN</sub> and I<sub>IN</sub> refer to control inputs. V<sub>I</sub>, V<sub>O</sub>, I<sub>I</sub>, and I<sub>O</sub> refer to data pins.

† All typical values are at V<sub>CC</sub> = 5 V (unless otherwise noted), T<sub>A</sub> = 25°C.

‡ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

§ This is the increase in supply current for each input that is at the specified voltage level, rather than V<sub>CC</sub> or GND.

¶ Measured by the voltage drop between the A and B terminals at the indicated current through the switch. ON-state resistance is determined by the lower of the voltages of the two (A or B) terminals.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4 V		V <sub>CC</sub> = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	
t <sub>pd</sub> #	A or B	B or A	0.24		0.15		ns
t <sub>en</sub>	$\overline{\text{OE}}$	A or B	5.1		1.5	4.7	ns
t <sub>dis</sub>	$\overline{\text{OE}}$	A or B	5.2		1.5	5.4	ns

# The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).



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undershoot characteristics (see Figures 1 and 2)

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{OUTU}$	$V_{CC} = 5.5\text{ V}$ , Switch OFF, $V_{IN} = V_{CC}$ or GND	2	$V_{OH} - 0.3$		V

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

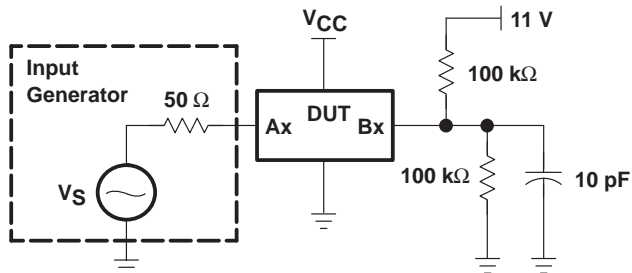


Figure 1. Device Test Setup

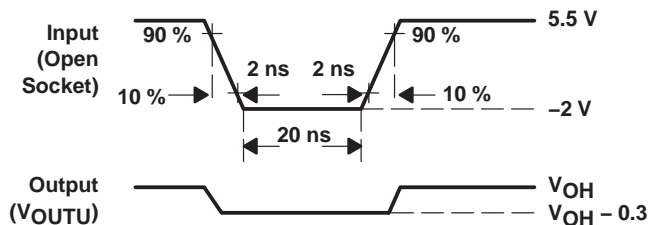
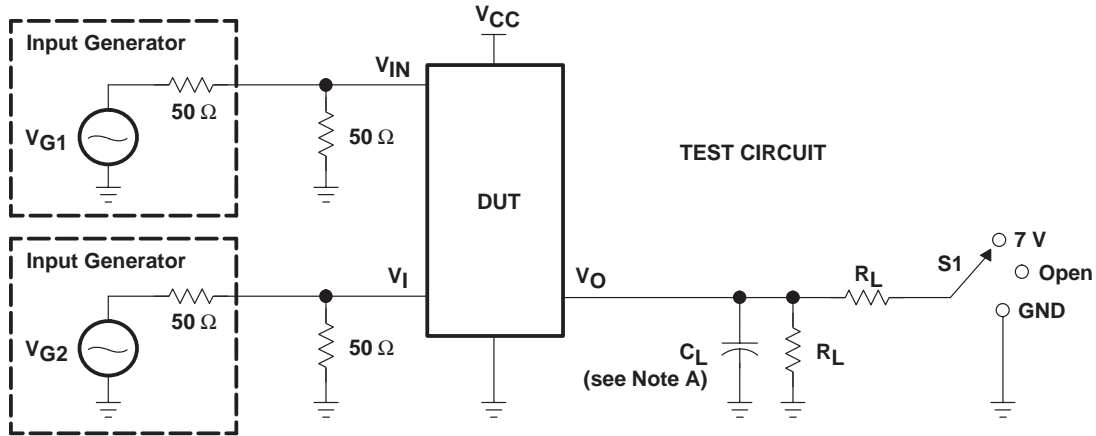


Figure 2. Transient Input Voltage ( $V_i$ ) and Output Voltage ( $V_{OUTU}$ ) Waveforms (Switch OFF)

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**PARAMETER MEASUREMENT INFORMATION**



TEST	V <sub>CC</sub>	S1	R <sub>L</sub>	V <sub>I</sub>	C <sub>L</sub>	V <sub>Δ</sub>
t <sub>pd</sub> (s)	5 V ± 0.5 V	Open	500 Ω	V <sub>CC</sub> or GND	50 pF	
	4 V	Open	500 Ω	V <sub>CC</sub> or GND	50 pF	
t <sub>PLZ</sub> /t <sub>PZL</sub>	5 V ± 0.5 V	7 V	500 Ω	GND	50 pF	0.3 V
	4 V	7 V	500 Ω	GND	50 pF	0.3 V
t <sub>PHZ</sub> /t <sub>PZH</sub>	5 V ± 0.5 V	Open	500 Ω	V <sub>CC</sub>	50 pF	0.3 V
	4 V	Open	500 Ω	V <sub>CC</sub>	50 pF	0.3 V



- NOTES:
- A. C<sub>L</sub> 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 ≤ 10 MHz, Z<sub>O</sub> = 50 Ω, t<sub>r</sub> ≤ 2.5 ns, t<sub>f</sub> ≤ 2.5 ns.
  - D. The outputs are measured one at a time with one transition per measurement.
  - E. t<sub>PLZ</sub> and t<sub>PHZ</sub> are the same as t<sub>dis</sub>.
  - F. t<sub>PZL</sub> and t<sub>PZH</sub> are the same as t<sub>en</sub>.
  - G. t<sub>PLH</sub> and t<sub>PHL</sub> are the same as t<sub>pd</sub>(s). The t<sub>pd</sub> propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).
  - H. All parameters and waveforms are not applicable to all devices.

**Figure 3. Test 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
SN74CBT16244CDGGR	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16244C	<a href="#">Samples</a>
SN74CBT16244CDGVR	ACTIVE	TVSOP	DGV	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CY244C	<a href="#">Samples</a>
SN74CBT16244CDL	ACTIVE	SSOP	DL	48	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16244C	<a href="#">Samples</a>
SN74CBT16244CDLR	ACTIVE	SSOP	DL	48	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16244C	<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.

**OBSELETE:** 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.

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**TAPE AND REEL INFORMATION**

**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
SN74CBT16244CDGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74CBT16244CDGVR	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	16.0	Q1
SN74CBT16244CDLR	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)
SN74CBT16244CDGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74CBT16244CDGVR	TVSOP	DGV	48	2000	356.0	356.0	35.0
SN74CBT16244CDLR	SSOP	DL	48	1000	367.0	367.0	55.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74CBT16244CDL	DL	SSOP	48	25	473.7	14.24	5110	7.87

# MECHANICAL DATA

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE



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

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

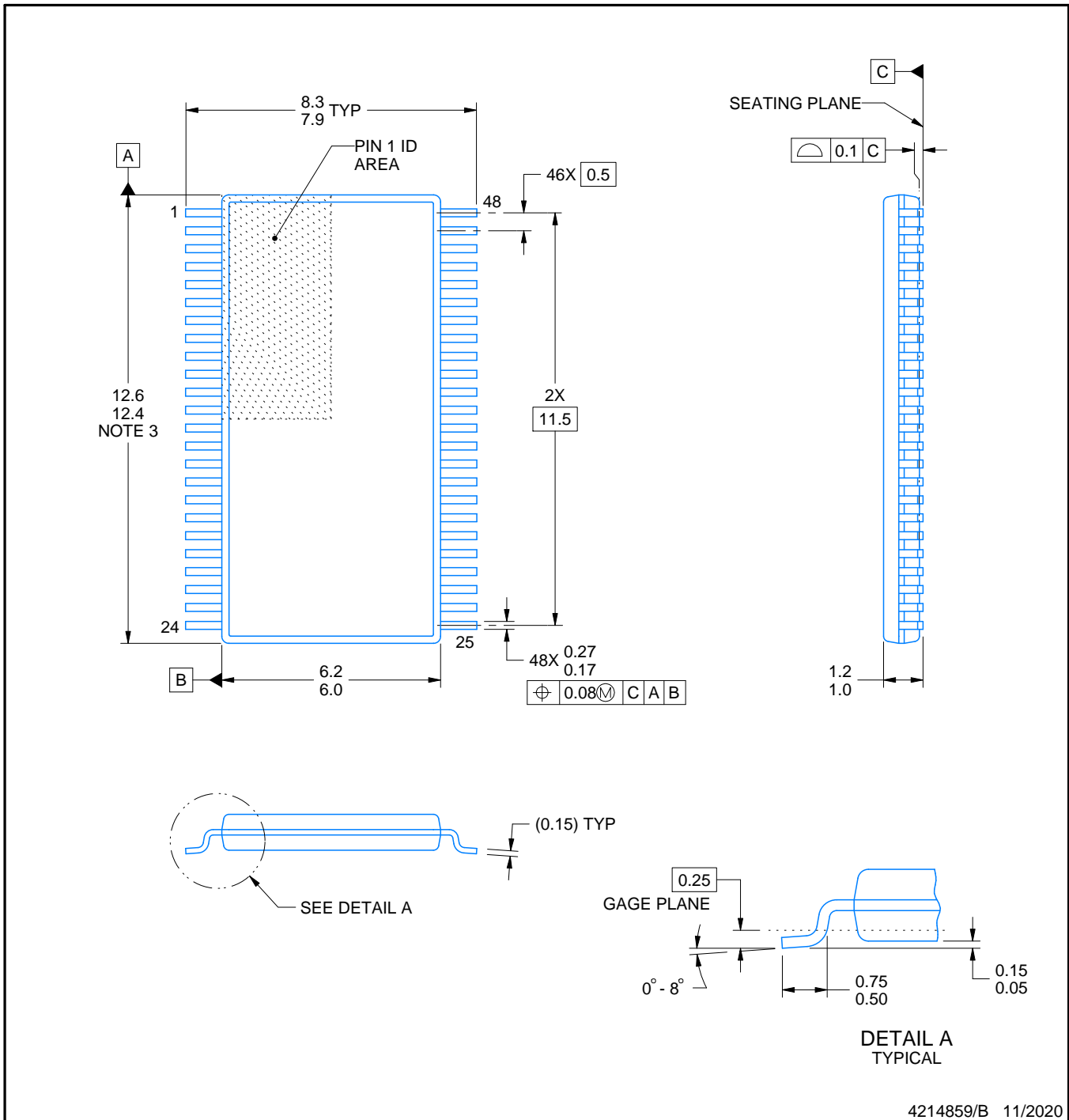
PLASTIC SMALL-OUTLINE

24 PINS SHOWN



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



4214859/B 11/2020

**NOTES:**

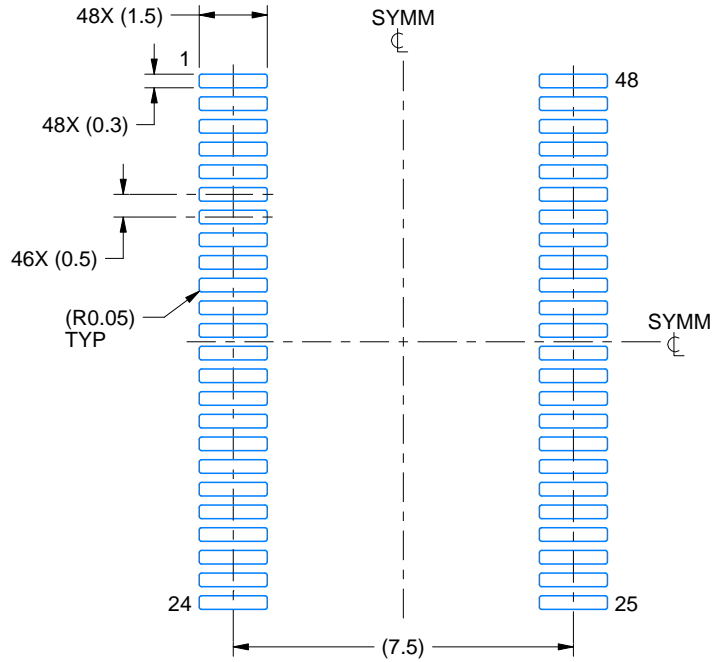
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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)

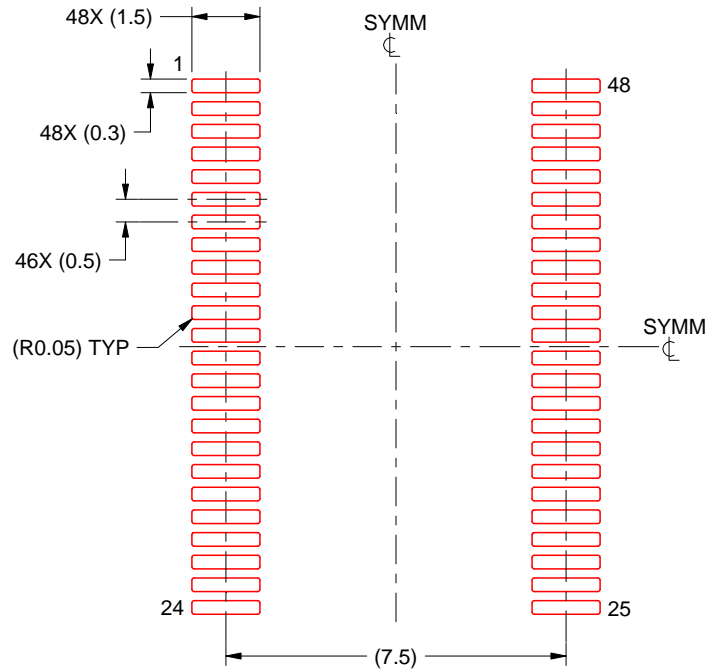
- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# 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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